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DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

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Edited by A. S. RUSSELL, M.C., D.Sc.

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DISCOVERY

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DISCOVERY. A Monthly Popular Journal of Knowledge.

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Editorial Notes

With these notes we introduce Discovery. The journal has for its aim a popular description of the advance made in the chief subjects in which investigations are being actively pursued. We hope to give also, from time to time, some account of new ideas in subjects which do not lend themselves to definite and concrete "discoveries" as ordinarily understood, but in which new methods and new points of view, of interest and importance to everyone, are being developed. The articles, singly or in a series, will deal with their subjects in such a way as to make clear the interesting features of the discoveries with which they deal, and will be written in plain, simple language by contributors who can speak with authority in their own branch of knowledge. The general reader, who has neither time nor opportunity to pursue specialised study, will thus be able to obtain at first hand an account, which he can understand, of the chief things which the experts are doing or have done in all the chief branches of knowledge.

* * * * *

Our aim is to interest the reader, not to preach any special doctrine, or to lecture on any particular subject. We are not, therefore, narrowing our attention to a few subjects, whether literary or scientific, but mean to take all knowledge as our province. Of course, in any particular number the limits of space will confine us to a few subjects only; but in time we hope to cover all subjects in which discoveries or new points of view are of sufficient interest to be described. At the present moment, while there are many periodicals which are written for specialists by specialists, and many more in which popular descriptions of discoveries are given by journalists, there is none in which the vast amount of new work and of new ideas in various subjects is described, either by the men themselves who are doing the work, or by men who are "inside" the subjects they are writing about. We hope to get such men to write for Discovery, and to write not in the language of their specialism, but in that simpler tongue which we plain men do understand—namely, English.

* * * * *

Our object, then, is to give readers an interest both in the Sciences and in the Humanities by making the work of the specialists in both as plain as possible. Whether we fail or not remains to be seen. We mean to try. It is a thing worth trying for. In the past, unfortunately, there has been considerable opposition between the representatives of science and those of the humane studies. Now, since the war, it is becoming abundantly recognised that the interests of these two somewhat artificial divisions of knowledge are not hostile, but complementary; and that the welfare of everybody depends upon advances being made in both of these, and on our recognising the necessity of both.

* * * * *

With increase in knowledge there has been a tendency for the specialist to separate himself from the amateur, the consequence being that the former works with, and on behalf of, a small hierarchy of kindred spirits, which has little or no dealings with outside people. The biggest things which these specialists do may, of course, become known after a time—often a very long time; but there are many interesting facts, theories, and points of view, not of such capital importance, which never come into the ken of the ordinary man or woman at all, simply because there is no easy channel of communication.

* * * * *

It is easier to suggest what these channels are, than to get the right people to make use of them. Popular lectures in the past have been a very useful means to the end we are seeking. When the lecturer really knows his subject, possesses a good voice and lantern slides, and, without telling his audience too much, keeps his remarks cheerful and witty, he gets an attentive hearing. But books and magazine articles must needs be the chief means of information. We hold that the specialist, when he has communicated his results to his fellow-workers in the ordinary way, should do the further work of making the same results plain to the ordinary man in books, pamphlets or articles easily understood. To review and recommend such books when they seem suitable, and to print such articles, is part of the work we have undertaken in bringing out DISCOVERY.

* * * * *

Having thus briefly described our aims, our intentions and our hopes, we may be allowed to describe shortly how DISCOVERY came into being. The first conception of the journal was due to the late Professor Julius Macleod, of Ghent, a distinguished Belgian botanist, who was a guest of the University of Manchester during the war. His suggestion led to a special conference between a committee of the Council of Humanistic Studies and a committee of the Conjoint Board of Scientific Studies. As a result of this conference, negotiations were commenced, which have since developed until the project has taken its present shape. In October of last year, it was decided that the magazine be maintained under a deed of Trust, the Presidents of the Royal Society and of the British Academy being two of the four trustees. It was decided also that the committee of management be composed of representatives of bodies which have joined in a guarantee of the initial expenses, and also of representatives of learned societies. The former bodies include the National Union of Teachers, the Co-operative Union, the Library Association, the Incorporated Associations of Headmasters and Headmistresses, and the Headmasters' Conference: the latter the Conjoint Board of Scientific Societies, the Classical, Historical, English, Geographical and Modern Language Associations, the British Psychological Society and the Royal Society of Economics. Each of these specialist bodies undertakes to supply, year by year, for our use, a list of contributors who are capable of representing its particular branch of knowledge in articles of a popular kind. We are thus doubly equipped in a way that few new periodicals have been. To a large extent we have found our contributors; to some extent our public awaits us. With this solid phalanx of good men to help us, we hope we have

"Caught soul
For the goal."

We shall welcome correspondence relating to the subject-matter of the articles, and also suggestions and criticism that may lead to the more complete fulfilment of our aims and intentions. A short list of books suitable for further study will be appended in most cases to an article. We hope these will be found useful. Occasionally, as in this number, it may happen that a writer recommends his own book. In such cases, it will be understood that the book mentioned is the best procurable, and has been given at our suggestion.

New Light on Old Authors

I. The Secret of Philæ

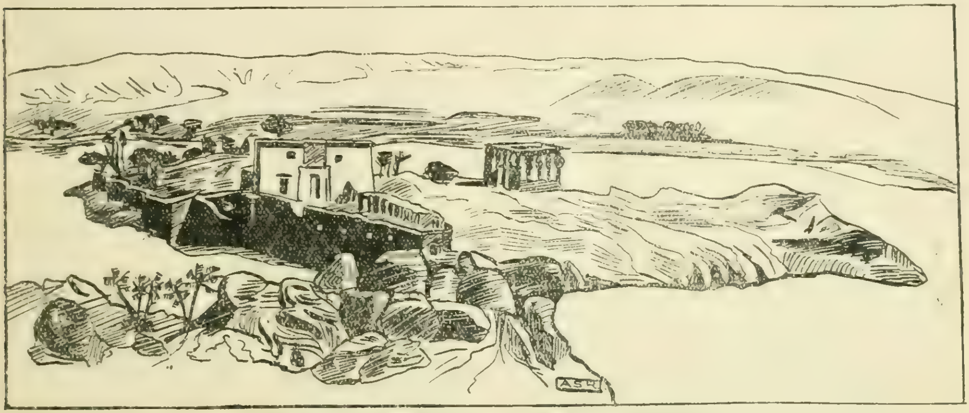
By R. S. Conway, Litt.D., F.B.A.

Hulme Professor of Latin in the University of Manchester

PHILÆ, the most famous island in the Nile valley, contains, as our illustration shows, several ancient temples, the oldest and most conspicuous having been built about 300 B.C. But all the visitor to-day can see of them is the summits of the tallest. The rest is now covered with water through the creation of the great reservoir by the new barrage of the river at Assouan. This colossal feat of British engineering is a permanent service to Egypt, since it has rendered perpetual what for untold centuries had been a matter of anxiety to the Egyptian nation every year, a full supply of Nile water to fertilize the fields; and some account of it may well be given in this journal on another occasion. This article is concerned merely with one of the many additions to our knowledge which has resulted from the survey of the ancient remains of the Nile Valley, which was begun and continued for many years by the Egyptian Government to anticipate the coming flood.

At the north-west corner of the island, which appears on the left-hand side of the illustration, there once stood a temple which has long since been almost levelled to the ground, but which in its day was the first thing on the island to meet the eyes of a traveller arriving from Europe. This, as we know from the inscription on its fallen portico, was built twelve years before the birth of Christ, to the honour of the Emperor

Augustus Cæsar, who had been supreme in Egypt since the defeat of the last Egyptian sovereign, Cleopatra, at the battle of Actium nineteen years before; the story of her death is, of course, familiar to English readers from the vivid scenes of Shakespeare's *Antony and Cleopatra*. After Cleopatra's death, Augustus had to decide the question to whom he should depute the government of the country, since it was a vitally important part of his Mediterranean system, and one of the chief sources of the corn-supply of Rome. He chose a young poet named Gaius Cornelius Gallus, who had won distinction also as a commander in the civil wars. Some of Gallus' own brilliant but uneven writing has lately become known to us, in a poem called the *Ciris*, now shown, quite certainly as some of us think, to be mainly his work. We know him to have been the school-companion and an intimate friend of a greater writer of his own age, the poet Vergil.[1] Now, Vergil was born and bred a farmer's boy, on the estate of which his father was at first only the steward, though later the owner; and one of his greatest poems, still read by thousands of boys and girls at school every year, is a description of the work which farmers do and its importance in human life as a whole. This poem Vergil called *Georgica*, that is, "Farming." His chief purpose in writing it was to describe the country-life he knew and loved; but incidentally he meant it to support the plans of the Emperor for restoring agriculture in Italy. The simplest and most familiar of its four Books is the last, which sets out to describe the keeping of Bees, and discourses profoundly and yet playfully on that topic for about three-fifths of its length. But at that point the poem takes a strange turn and relates, in quite a different style, two or three old-world legends, very slightly strung together and still more slightly connected with the keeping of Bees. The chief of them is the famous story of the singer Orpheus, who went down to the World of the Dead to fetch back his beloved Eurydice, and lost her again because he looked back upon her too soon. This short poem, which is really complete in itself, is so beautiful and has seized the imagination of so many poets—not to mention the musicians—of later ages, that people have read it gratefully where it stands, without troubling themselves with the curious question why Vergil should have tacked it on to a poem about Farming. Indeed, in the nineteenth century most Latin scholars—especially in Germany, though not only there—were accustomed to pooh-pooh the explanation of it given by the commentator Servius, who lived in the fourth century, though nearly all his positive statements about Vergil are drawn from much earlier writers who knew Vergil himself. But this explanation has now been confirmed, past all dispute, by the discovery in 1896 of an inscribed stone built into the paved approach to the temple of Augustus which, as we have seen, was built at Philæ; and few discoveries have thrown more direct light on the critical period in the world's life that just preceded the birth of Christ, or on the inner experience of one of the greatest, if not the greatest, of the world's poets. But though the stone was found in 1896, none of the editions of Vergil printed or reprinted since then, and probably none of all the teachers concerned in interpreting him to English schoolboys, make any mention of it.



PHILÆ AND ITS TEMPLES IN 1900; FROM BIGA, LOOKING N.E.

What, then, does Servius tell us about the end of Book IV of the *Georgics*? Originally, he says, the conclusion contained an account of Egypt, including its production of honey, and " the praises of Gallus " ; but after Gallus had fallen into disgrace and committed suicide, Vergil substituted the present ending with the stories of Aristæus and Orpheus. The explanation is, in fact, by no means hard to accept ; for no account of farming in Vergil's time could have altogether omitted Egypt, then the world's greatest granary ; nor could any poem whose author desired to help Augustus have been altogether silent about his addition of that famous and ancient kingdom to the Roman Empire ; nor can anyone who has realized the kind of man Vergil was, and the kind of affection he had for his friends, imagine that he could have failed to notice the fact that the newly added realm was governed by his friend and fellow-poet Gallus.

---

[1] The Italian form *Virgilio* gave *Virgil* in English, but most scholars now prefer to follow the Latin form of the name, which was *Vergilius*.

Nevertheless our paştors and teachers who belonged to the epoch of Mommsen (when it was almost a point of honour to reject every ancient statement against which even the faintest doubt could be raised), though they did not indeed deny that Gallus had been governor of Egypt and had fallen out of power, would not recognize this as a sufficient basis for Servius' story, and wrote of Vergil and Gallus as though they belonged to different worlds, instead of being what they surely were, the David and Jonathan of their day. Perhaps unconsciously they were influenced by the desire not to connect Vergil so intimately with a man whom they regarded merely as a traitor.

Now, what does the inscription of Philæ add to our knowledge ? It gives us the very words written to record the victories of Gallus, in Egyptian, Latin, and Greek ; those in Latin at least being certainly what Gallus himself wished to state. He makes a votive offering to " the gods of his country and to the River Nile who aided him," and describes himself in flowery, poetical language as " the subduer of the whole Thebaid region in fifteen days " ; as " having carried his armies above the cataract of the Nile to a spot never before reached by the Roman people or by Egyptian Kings," as having " inspired with terror all the chieftains of the region," and taken five cities (now lost in the desert sand). All this Gallus has done ; whereas his imperial master receives only a brief mention at the beginning as having " conquered the Kings of Egypt "—that is, Cleopatra and (probably) Antony.

And what was the large portrait cut deep in the stone in the centre of the inscription ? It represented someone on horseback riding down upon a suppliant foe—and Gallus was a Roman knight—but the features have been deliberately hacked out. For what reason ? For the same reason which led the builders of the Temple of Augustus to place the whole slab with the inscription face upwards to be trodden on by everyone who approached to worship at the Emperor's shrine—namely, to do dishonour to Gallus ; it was Gallus' own picture that Gallus the prefect set up, and that his successors cast down and defaced ; and to set up one's own portrait in the East in ancient times was to claim for it something like divine honours. Now we see the boyish vanity into which the young poet-soldier was betrayed, partly no doubt by his first experience of the flattery of Oriental attendants, partly by his own love of glorious words ; and we see also how fatally easy it was for his enemies to misrepresent his attitude towards the Emperor.

One curious circumstance indeed reveals, almost by accident, what Gallus' inscription looked like to people in Egypt, and what a real danger it was, in fact, to the supremacy of Augustus for his lieutenants to be so boastful. The Egyptian inscription, which comes first, makes no mention, so the Egyptologists assure us, of Gallus' own name, but summarizes the events briefly and gives the credit either to Cæsar himself or " the præfect of Cæsar," if that be the right restoration of the Egyptian text. This was the true and old Egyptian fashion, and may, indeed, have been done with Gallus' approval or even at his command ; but to anyone who could understand the Latin or Greek as well as the Egyptian the contrast would be striking ; and to everyone, the appearance of Gallus' own portrait, not that of the Emperor, in full Roman style, between the names of six Egyptian deities, would be not less startling. Poor Gallus ! Like many another lad of brilliant powers and quick imagination, he lacked the sense of proportion without which no man is safe in high places, least of all in the East. Gallus was accused before the Senate and deprived of his command ; and learning that Augustus had expressed displeasure at what he had done, he killed himself. But the Emperor wept when the news was brought to him, and complained bitterly that he alone of all men was not allowed to be angry with a friend without some tragic consequence. The inscription which Philæ has preserved for us shows in every line the real nature of the tragedy. With no thought of treason to his master, though with no sense of the restraints which his own position demanded, the young Provençal poet plunged into a folly which even veteran statesmen have found it hard to resist. But his folly was not one that greatly lowers our regard; still less can it have robbed him of Vergil's affection, alien though it was from Vergil's own temper. With Gallus' words and his expunged portrait before us we understand the pathos of his fall—how innocent he seemed to himself, how guilty to everyone else. And we understand something of the tragic disappointment and lifelong sorrow of his friend Vergil, and something of the bitter regret of the Emperor. And it is no longer strange, but perfectly natural, that after such a tragedy, the name and achievements of Gallus could not remain to make the climax of a great poem written by Vergil, and written partly in aid of one of the Emperor's great patriotic schemes. It is no longer strange, but perfectly natural, that, in piecing together three youthful poems (*Aristæus*, *Proteus*, *Orpheus*) to take the place of the lost *Praises of Egypt and of Gallus*, ingenious as the links inserted between them are, the great poet should have had no heart in his work, and should have left in despair the many broken threads of the supposed story to be a silent record of the bitterest sorrow of his life.

NOTE.—Some account of the Greek and Latin inscriptions was given in the *Athenæum*, March 14 and 21, 1896. Professor Sayce discussed the Egyptian text in the *Academy* shortly afterwards. Mommsen wrote an article in German in *Cosmopolis* (London, 1896, p. 545), in which he is characteristically silent about the statement of Servius. The best book for students to consult is *Aus Vergils Frühzeit* (pp. 140 ff., Leipzic, 1901), by the late Professor F. Skutsch, of Breslau, whose work in this and in many ways opened a new epoch in the study of Vergil. Some account of Gallus and his relations with Vergil will be found in a recent lecture of my own called *The Youth of Vergil* (Manchester, 1917).

Smoke Screens at Sea

By T. Slater Price, O.B.E., D.Sc.

Lieut.-Commander R.N.V.R.; Head of Chemistry Dept., Birmingham Municipal Technical School.

IN land warfare smoke screens have been used from the earliest times for the purpose of hiding operations in the field, but it was only during the recent war that serious attention was given to the subject and attempts made to put it on a proper scientific basis. In the navy, the method of producing a thick black smoke, which can be emitted in great volume from the funnels, has long been known, and tactical use made of it when occasion demanded. During the war, however, as the necessity arose for counteracting the submarine warfare of the enemy against defenceless merchantmen, and of undertaking operations against land stations defended by modern resources, new methods of producing smoke had to be devised. These methods had, in many cases, to be independent of any mechanical arrangements or motive power on board ship, since when the vessel was being chased by a submarine, for example, it was an advantage for it to be able to throw overboard a float containing the smoke-producing mixture, and thus hide its own course in the screen produced.

It is obvious that one essential condition to which a smoke screen must conform is that of remaining near to the surface of the water or land. This condition is perhaps more easily satisfied on sea than on land, since on the latter, during the time when smoke screens are of use—that is, in the day-time—the tendency is for the ground to be hotter than the air above it; the result is that hot air is rising upwards continually, and these upward currents tend to make any smoke screen rise. This effect is particularly noticeable on a bright, sunshiny day. On the other hand, over the sea the temperature gradient in the day-time is generally such that the air near the sea is colder than the superincumbent air, and the sea itself is at a lower temperature than the air in contact with it. A smoke cloud at sea will therefore tend to keep near the surface much more readily than is the case on land.

It is easily seen that, in order best to satisfy the condition under consideration, the particles of the cloud should be fairly heavy; they must not, however, be too heavy, otherwise the cloud will sink too rapidly into the sea and thus lose its effectiveness as a screen. It is very advantageous if the particles are of a hygroscopic nature, since there is then a tendency for the cloud to become thicker for some time after it has been produced, and not dissipate so quickly. In accordance with this, it has been found on land that a denser and lower cloud is formed when the atmosphere is nearly saturated with moisture than when it is fairly dry; the conditions over the sea are consequently more advantageous in this respect than over land.

The velocity of the wind has a marked effect on the smoke; clouds which would tend to rise if produced in still air, or in a low breeze, will be kept well down when there is a good breeze blowing. It must be remembered, however, that a cloud dissipates more quickly in a wind of high than in one of low velocity, so that for the same screening effect a much greater amount of smoke must be generated in a given time in a high wind than in a low one. This action of the wind in keeping down the smoke is of very great importance. Usually a great amount of heat is generated in the reactions which produce some of the most satisfactory smokes; this gives rise to strong currents of hot gases, which would carry the smoke upwards were it not for the counter-action of the wind. When smoke is actually produced on board a ship under weigh there is the distinct advantage over land conditions that the smoke is sucked down to the surface of the water by the inrush of air created at the stern of the ship.

Before dealing with the various methods for making smoke, the question of measuring the relative opacities of different smokes may be briefly referred to. Measurements have been made, both in this country and in America, by determining the distances at which an electric lamp is just obscured; knowing the quantities of material used in the production of the various smokes, their relative screening powers could then be calculated. These measurements have naturally been carried out in an enclosed space, and it is a moot point as to how far the results obtained are valid for the open air. The efficiency of a smoke screen depends to a great extent on the conditions of lighting, and on how the observer is situated with respect to the source of light. One has only to think of the case of a room lit by a window looking on to the street and covered with a screen or curtain of meshed material. In the day-time a person in the room is screened from observation from the outside, although he can observe everything going on in the street; at night-time, when the room is lit up by an inside light, the conditions are reversed.

The fuel smoke which is usually made by vessels of the fleet has already been mentioned. It has the characteristic of most black smokes—namely, that it is made of particles of unburnt or partly burnt carbonaceous matter, and is consequently far from heavy. It is dissipated fairly rapidly, and only forms an effective screen when continuously produced in large quantity.

Practically all the effective smoke screens which were produced artificially were white, and mention will now be made of some of these.

The first introduction of a smoke-producing agent into the services involved the use of phosphorus, and special apparatus was designed by Sir Richard Threlfall for burning it at sea. The apparatus could be placed on deck and the phosphorus fired in position, or it could be modified in such a way that it floated when in the sea and could be left functioning while the ship proceeded on its course. There is no doubt that, weight for weight, phosphorus has a great advantage over practically all other smoke-producers, since only oxygen is necessary for its combustion, and this is available in the air in unlimited quantities. The particles of phosphorus pentoxide produced are exceedingly hygroscopic, and the cloud formed is a very good one, although, because of the heavy nature of the particles, it tends to settle somewhat rapidly. Owing to the great rise in temperature caused by the combustion of the phosphorus, there is a distinct tendency for the smoke to arch in low winds. This method of producing smoke was used with great success early in 1917 for the purpose of screening monitors when bombarding the Belgian coast. It was abandoned later, however, partly owing to the dangerous nature of phosphorus itself, when used on board ship, but chiefly because of the extremely bright light which is produced when phosphorus burns. The emission of this light makes it an easy matter for guns to be ranged on the vessel producing the smoke, and renders the method quite useless for night operations.

Since the supply of phosphorus was limited, and it was urgently needed by the army as a smoke-producing substance, the necessity arose of replacing it by some smoke-producing material which could be stored in appropriate floats on the decks of merchantmen or other vessels, the floats then being lit and thrown overboard when occasion demanded. The late Wing-Commander Brock, R.N., Commanding Officer of the Royal Naval Experimental Station, Stratford, E., devised a mixture which was really a firework composition, modified in such a way, by the addition of resinous and other carbonaceous material, that a dense smoke was produced on burning. This mixture was placed in tin canisters contained in a wooden box, each canister being connected by a fuse to a match composition (suitably protected) on the outside of the box, and which could be fired by friction. Near the top of the sides of the box were a number of small holes, that were plugged by a composition which would easily be blown out by the pressure set up in the box by the gases produced in the burning of the smoke mixture. The boxes were so arranged that they floated in water, the top side uppermost, and all that was necessary, in using them, was to strike the friction tab and then, when it was certain that they had started functioning correctly, throw them overboard. The results obtained were not very satisfactory, however, owing to the difficulty of keeping the boxes watertight, and the smoke-mixture free from moisture. Also, the smoke produced suffered from the same defects as the fuel-funnel-smoke.

There are several chlorides of metals and non-metals, such as stannic chloride, antimony pentachloride, silicon tetrachloride, etc., which give a good smoke when decomposed by the moisture of the atmosphere, or especially when a fine spray of the liquid is mixed with a fine spray of liquid ammonia; stannic chloride especially gives a very good cloud under such conditions (see English Patent 127289). To use these substances, however, they have to be stored in heavy steel cylinders under a considerable pressure of air, in order to force them out as a spray through a syphon tube; the dead weight of the containing-vessels is thus very large in comparison with the weight of smoke-producing material. Moreover, the contents of a cylinder are discharged in the short time of 6–8 minutes. This method of producing smoke is therefore not very convenient on a large scale, but it has the advantage that smoke can be produced instantly, and in quantity, by the mere turning of a tap.

A smoke mixture which has found extended use, and which depends on a principle not previously used, is that devised by Berger.

The English Patent 127031, which has been taken out by Berger, is somewhat as follows: "Fumes or vapours for concealing military operations are produced by the combustion of mixtures of chlorides of metals or non-metals, or chlorinated hydrocarbon derivatives, with a metal, non-metal, or a sulphide, or with a mixture of an oxide and reducing agent, or with a mixture of an oxide, an excess of a reducing agent, and an oxidizing agent. For example, the mixture may contain· tetrachlorethane 40, zinc oxide 20, zinc dust 15, calcium silicide 15, and sodium chlorate 10 per cent."

If carbon tetrachloride is used as the chlorinated hydrocarbon, the production of smoke really depends on its interaction with the zinc, zinc chloride thus being formed. In order to prevent the deposition of carbon at the same time, oxides are added, and the metals of these oxides, after furnishing oxygen to the carbon, are also transformed into chlorides and add to the smoke. Kieselguhr is often added, and this serves the purpose of absorbing the carbon tetrachloride, thus furnishing a pasty mixture which can readily be handled, and of which the constituents do not separate out. In order to start the reaction it is necessary to heat a portion of the mixture to a high temperature by means of a special thermite igniter. Once the reaction has started it proceeds with great vigour, and a dense white smoke is emitted in great volume. The particles of this smoke consist essentially of the hygroscopic chlorides of zinc and other metals, with the result that the cloud becomes denser a short time after it has been formed.

The Berger mixture could not be made in this country, since some of the necessary ingredients were not available in quantity. Extended series of experiments and trials were therefore carried out at the Royal Naval Experimental Station, Stratford, E., with the result that several different mixtures, containing ingredients which were available in quantity, were devised. These mixtures were manufactured on a large scale and filled into floats for use at sea. These floats consisted essentially of a cylindrical metal container, approximately 8 inches by 28 inches, surrounded by an air chamber of sufficient size and shape to make the whole thing float upright in the sea with a free-board of a few inches. The mixture, as soon as it was made, was put into the float and a lid soldered on. The lid contained a central, screwed hole, for the insertion of an igniter when occasion demanded ; until required this hole was sealed by a screw plug. Around the central hole was a number of smaller holes or vents, closed by means of soldered-on tin discs. The method of using a float was to insert the igniter, strike the friction tab on the top, and then throw the float overboard. The delay in the fuse in the igniter was sufficient to allow the float to come to the surface of the water before the thermite really caught fire. As soon as the smoke mixture started burning the heat developed was sufficient to melt the solder fastening the tin discs over the vents, with the result that the latter opened, and smoke issued in volume from the vents and the central hole where the igniter had been. A single float would burn for 15–20 minutes, emitting a cloud which would extend as an efficient screen for 1,000 yards or more. With several floats a most satisfactory screen could be obtained.

Instead of throwing the float overboard, it could be burnt on deck if the wind conditions were satisfactory.

In order further to simplify the working of a float, an igniter was devised which was actuated by coming into contact with water. All that was necessary was to tear the cover off the igniter after it had been inserted in the float, and then throw the float overboard. The igniter contained a special chemical mixture which ignited as soon as it came in contact with the water ; this fired the thermite, which then started the combustion of the smoke mixture.

There is no doubt that this mixture was also the most satisfactory for certain purposes on land, but it was not used to any great extent, as the supply of material was sufficient only for naval purposes. Successful efforts were made at Stratford to adapt it for use in Stokes bombs, and had the war continued it might have found extended application in that and other directions.

The last smoke-producing substance to which reference will be made is chlorosulphonic acid. It is well known that this substance fumes violently when exposed to moist air, and the Germans made use of this property in a stationary smoke apparatus for land purposes. Crude chlorosulphonic acid, or a mixture of chlorosulphonic acid and oleum, was contained in a drum suspended over a vessel containing quicklime. When the drum was turned over, the chlorosulphonic acid ran out through a hole on to the lime. The heat of reaction between the lime and the chlorosulphonic acid was sufficient to vaporize the excess of the latter, which was thus driven into the air and gave a dense smoke when the air was sufficiently moist. On a dry day, when the air contained very little moisture, the smoke was apt to be somewhat thin.

When the production of smoke from chlorosulphonic acid for naval purposes was discussed at Stratford, it was pointed out that the German method involved a considerable waste of smoke-producing material, which was used up in combining with the lime. Since there are numerous sources of heat on board ship, it was suggested that they should be utilized for vaporizing the chlorosulphonic acid and so forming smoke. This suggestion was accepted by Commander Brock, and after an extended series of experiments satisfactory methods were developed. It should be noted that the best results can only be obtained if the chlorosulphonic acid is heated suddenly to a temperature above its boiling-point. If attempts are made to vaporize it by boiling, a partial decomposition takes place into sulphuryl chloride and sulphuric acid; the former decomposes very slowly with water vapour and is of very little use as a smoke-producing agent, whilst the latter gradually accumulates in the boiling liquid. In order to obtain complete success, it is furthermore necessary that the vapour of the chlorosulphonic acid, or its decomposition products, should come into immediate contact with an excess of water vapour. If attempts are made to use chlorosulphonic acid without supplying it with a sufficient amount of water vapour, the smoke produced, even over the sea, is liable to be somewhat thin on a dry day.

The conditions necessary for success were satisfied as follows, the particular methods of application being due to Commander Brock:

(*a*) The chlorosulphonic acid is fed as a fine spray into the funnel of a destroyer. The temperature of the waste products of combustion from the furnaces is sufficient suddenly to vaporize the acid, and the water vapour present completes the formation of the cloud.

(*b*) The chlorosulphonic acid is dripped into the exhaust pipe of a petrol engine on a motor-launch or coastal motor-boat. The effect is the same as in the funnels.

Both these methods were used with great success in the raids on Zeebrugge and Ostend. Method (*b*) was also adapted to land tanks, a number of these being fitted up by a special experimental party sent out from the Stratford Naval Station.

Another method by which a very good smoke can be obtained from chlorosulphonic acid is to force it through a special spray nozzle by means of steam, the acid and the steam being brought into contact just at the orifice of the nozzle.

It may be mentioned that the smoke produced by chlorosulphonic acid, when sufficiently dilute, is hard to distinguish from a sea mist, and no unpleasant effects are noticeable on the face or when breathing it.

Suggestions have often been received that ships should be able to protect themselves by smoke screens all the time they are in waters infested by enemy craft. This, however, is not a feasible proposition at present, since the carriage of the smoke materials would necessitate a very large additional load on the vessel. Such a project may ultimately be realized, but it may be pointed out that practically all the readily available substances capable of producing smoke are now known; whether satisfactory new substances will be discovered in the future remains to be seen.

The Modern Study of Dreams

By T. H. Pear, M.A., B.Sc.

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"It's only a dream," is a comment which most of us make frequently without realising what a challenge our utterance is to the twentieth-century psychologist. The educated scientific person of to-day generally thinks of the dream as a trivial, absurd and nonsensical structure. Yet it is interesting to note that the simple mind, uninfluenced by the teachings of materialistic science, has always believed in the dream's importance.

And to-day there exists a band of workers who once more regard the dream as deeply significant. They were recruited from a field of study in which at present there reign almost supreme those materialistic views which would belittle the dream—the realm of medicine. For doctors deliberately to choose to investigate fantastic, meaningless, trivial mental phantoms like dreams, when every medical school offers them rows of solid brains, thousands of microscope slides with nerve-cells and fibres already stained and mounted, when all round them are people suffering from serious mental disorders, when everyone knows that those disorders are in some way connected with the brain; does this not seem like fiddling while Rome burns?

The answer is simple: yes, if one asserts that the only way to discover the nature of mental occurrences is by examining their underlying bodily mechanisms; no, if one believes that a mental event can be examined by mental means, and explained in mental terms. But, a critic may ask, and in all seriousness and honesty, why not study the more orderly, more manageable events of the mind?

An answer may be given by an example taken from another field of science. Many years ago our critic might have wondered at the strange behaviour of a man who chose to fly a kite during a violent thunderstorm. Even at the time the kite-flyer could have given very cogent reasons for his action; nowadays every schoolboy understands that much of our modern knowledge of electricity was made possible by this apparently eccentric performance. But not only does the explanation of the thunderstorm now form part of an educated person's common sense, it helps us also to understand the more difficult problems of the workings of electricity in every-day situations. So it is with the dream; its processes are cruder than those of the mind doing its every-day work; it is controlled by less complex forces; its behaviour is therefore simpler and often easier to comprehend.

And the study of the dream has already carried its investigators some distance towards the understanding of those thunderstorms of the mind which men call insanity.

To say that the study of the dream lies to the credit of twentieth-century psychology is to make a statement almost startlingly precise; for the foundation-stone of this new structure of knowledge bears the year 1900, the date of the publication, in Vienna, of Sigmund Freud's *Traumdeutung* (*The Interpretation of Dreams*). To indicate in a few pages the significance for psychology of this pioneer work is difficult; to represent fairly Freud's theory in ten times this space is impossible. The reader therefore will understand that the few glimpses which this article may afford him must inevitably suffer from incompleteness and not a little angular distortion.

Freud's way of viewing, not the dream alone, but the whole world of mental events, is characterized by two important beliefs, both of which must be grasped if his standpoint is to be appreciated. The first is that all mental happenings are explicable in mental terms; that an account of them in terms of material processes occurring in brain or body may supplement, but can never replace, the other direct explanation. A dream, then, can be analysed into factors which are just the experience of the individual; the stuff, so to speak, with which the explanation deals is mental.

The second belief is that in the mind, as in the body, there is no room for the action of chance; all mental events are regarded as the results of preceding mental events, and as strictly determined by them. For Freud nothing accidental can ever happen in the mind. Every mental occurrence, however trivial, nonsensical or mad it may seem to others, or even to the experiencer himself, is the effect of preceding mental causes.

We may now attempt to explain the way in which a dream can be analysed by Freud's method. If the reader, when he reaches the latter part of this article, will bear in mind a distinction which will now be made, he will be in a position immeasurably superior to that of many of Freud's critics. This distinction is between the *manifest content* and the *latent content* of the dream. According to Freud, that which people commonly term "the dream," that conglomeration of experiences which they relate, not seldom with additions and suppressions, to a more or less appreciative breakfast-table audience, is merely the aspect of the dream which is "manifest" to them. It has been formed from material which at the time of dreaming was latent, hidden from consciousness, just as a Member of Parliament is the manifest representative of some of the opinions of numerous latent people called his constituents.

The way in which Freud formed this theory of the dual nature of the dream should not be difficult to understand by anyone who has ever detected in his own dreams the composite nature of some of the apparently new images which they contain. We may take one of the simplest examples from the writer's own collection. The dreamer noticed that the right-hand side-line of a Badminton Court was curved like a snake, and thought that, while this addition might make play more "sporting," it tended to spoil the game. On awakening he saw at once that this picture split up into two components: an actual Badminton Court to which, on the night of the dream, he had introduced a keen golfer, and a serpentine bunker which his enthusiastic guest had described to him.

Now Freud goes so far as to say that *all* dream-pictures, whether recognized as composite or not, are in reality made up of memories, and that not only is their combination effected according to definite principles, but that the combination itself performs a definite function.

To understand how it is possible to arrive at such a belief we must grasp the broad difference between two ways in which the mind can remember—by directed or by free association. If a man, looking at his blotting-pad, notices that it is thick, pink, oblong, new, and absorbent, this expression of the workings of his mind may not seem unusual, either to himself or to another. But if on glancing at it he should remark, "pink, sweet-pea, flower show, Wales, Criccieth, Prime Minister, politics, housing problem, huts, Pacific Islands," a spectator's comment might be that the list sounded like the ravings of a madman. It is improbable that he would realize how near to an accurate statement of fact he had been, and that the difference between a sane man's directed association and the maniac's apparently free association is merely one of degree. For the first list above was compiled by allowing the blotting-pad to dominate the thinker's mind; the second by employing the blotting-pad simply as a launching-place for the memories which were then allowed to run freely.

But *were* these memories "free"? To the ordinary English reader of this article the connexions between the last six of them should be obvious enough—to the thinker himself the other connexions are traceable to personal memories. All that is meant here by "free" is that the tendencies directing the path of association of the ideas in the mind at the time, are less easily discovered. Instead of one main idea (that of the blotting-pad) dominating the flow of thought, the direction was taken over in turn by several subjects—by holidays in Wales, politics, and the solution of the housing problems in this country and elsewhere.

This "free" association occurs whenever there is removed from our minds the dominating influence of a conscious guiding idea. Freud claims that when this occurs, unconscious directive tendencies take over the function of guiding our thoughts, and that in this way, by "freely associating" from any part of the manifest content of our dream, we can discover the underlying latent material of which it is the representative in our consciousness. In this way we can pass from the manifest to the latent content of the dream.

The transformation of the latent content of the dream into its manifest content is called the *dream-work*. This dream-work is not carried out during the occurrence of the dream, but according to Freud goes on incessantly both in our waking and sleeping life. The dream he compares to a firework which, though its display lasts only for a few seconds, may require many hours for its preparation.

What is the function of this dream-work? It is to distort or transform the latent content into a shape in which it is acceptable to our consciousness. And here we enter upon a part of the theory which can only be inadequately sketched in this short essay. It is well known that the activity of consciousness is always selective, that any thought temporarily in consciousness is simply the apex of a pyramid of memories associated with it. If that thought be allowed to develop, some of those memories will emerge into consciousness, while others will not.

Freud believes that one of the most important functions of consciousness—that which he pictorially terms the censorship—is to shield the mind as far as possible from experiences which would be unacceptable to it. In waking life the function of this censorship is usually to repress certain thoughts and desires, the dim premonitory shadows cast by the coming events being sufficient to ensure a refusal to admit them to consciousness. In sleep, however, the vigilance of the censorship being relaxed, the forbidden thoughts—banned because of their painful, immoral, or ugly nature—may clamour for admittance. The dream, according to Freud, is a compromise by means of which these thoughts or desires are allowed to enter consciousness, but in a disguised form. This distortion allows them to pass the relaxed censorship, and at the same time permits the sleeper to continue sleeping: for, Freud believes, had the banned material entered the sleep consciousness in its undisguised form, it would probably have wakened the sleeper in the form of a fear-dream. According to this theory, then, the dream is a preserver, not a disturber, of sleep. The sole exception occurs in the case of the fear-dream.

The processes of the dream-work which Freud has described are of intense interest to psychologists, for even if his theory of their function prove to be incorrect or inadequate, there appears to be ample evidence confirming the accuracy of his description of them. The evidence, indeed, makes it extremely probable that these processes are active, not only in fashioning dreams, but in the work of the waking consciousness of creative imagination, of literature, poetry, and art, the relation of which to the dream many before Freud have already suspected, though none have discovered or explained.

In the dreams of ordinary people, the scenery and the actors are usually fashioned out of visual images, of "pictures in the mind's eye." It is therefore natural that the dream should be essentially symbolic. But, according to this theory, not only may each person or thing in a dream, but any part of them, any dream-word heard or seen, be symbolic of a whole mass of meaning, which is represented by this complex symbol or *condensation*.

Thus in one of the writer's dreams which was analysed in detail,[1] the stage and scenery proved to be composed of two city squares, four restaurants, two lantern-screens, two laboratories, and two manuscript papers, while even the speech heard was a condensation of two such sentences. Moreover, each of these visual symbols represented extremely rich meanings in the dreamer's life, all of which were strictly relevant to the theme of the dream—the temptation to break a promise already given. Even in every-day life, however, symbolism often exhibits condensation, as anyone can see who cares to examine the badge of the Royal Army Medical Corps, or the Union Jack.

The next process of the dream-work, that of *Displacement*, follows inevitably from symbolism and condensation. To employ once more our example of the Member of Parliament, there must be many Members of the present Coalition Government who act as symbols for a very closely packed condensation of the heterogeneous desires of their constituents. It therefore comes about that some of those desires are not fully represented by the subsequent behaviour of the person who was elected to represent them. So it is with the dream; the formation of a compromise-symbol will inevitably involve a displacement of the relative importance of the several desires represented by it, and therefore the part of the manifest dream which appears to be most important for the dreamer will, on examination of the latent content, often prove to be less so. Freud, however, regards such displacement (together with other mechanisms which cannot be discussed in this short article) as further devices to evade the censorship of consciousness.

What, then, is Freud's view of the *meaning* of the dream? It is that the dream is the disguised fulfilment of a wish, which, being unacceptable to the censorship of consciousness, has been repressed into unconsciousness. It is no part of this essay to criticize this interpretation of the dream's function. The meaning which Freud attaches to the word "wish" is vastly wider than that which it bears for the average reader; or for the average psychologist. But there is steadily growing a mass of material which supports the belief that, if Freud's theory be broadened to include as the inciters of dreams, besides unfulfilled (as well as repressed) wishes, fear, ambitions, remorse, revenge—in fact, any powerful emotional experience behind which lies the driving force of the fundamental instincts—it provides us with an explanation of many otherwise inexplicable dreams.

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[1] *British Journal of Psychology*, 1914, vol. vi, pp. 292–302.

A dream of Dr. Bernard Hart's[1] shows clearly how a constellation of ideas or "complex," unacceptable to the personality in waking life, may manifest itself in the sleep-consciousness:

> "A colleague who occupies a post senior to me upon the staff of —— recently applied for an appointment at another institution. His success would have meant my promotion—but he happens to be one of my greatest friends, and I should certainly resent the suggestion that his departure could occasion me anything but genuine sorrow. Nevertheless I dreamt this dream: He and I were endeavouring to write in an inconceivably small room. The space was so cramped that the movements of one constantly interfered with those of the other. A quarrel resulted, and I had the satisfaction of finally pushing my colleague and friend outside the door. In other words, the complex whose existence I would not acknowledge in the waking state managed to express itself in a symbolical form during sleep."

We cannot close this essay without referring to the views of Dr. C. G. Jung, who, beginning as Freud's pupil, has now diverged from his former teacher in several directions. He believes that Freud has given us only a partial explanation of the dream, in that, looking into the past, he has traced the dream back to the memories which compose it. But to this retrospective interpretation he would add a prospective one: that the dream represents an attempt by the mind to adjust itself to the requirements of the present or of the immediate future; that if one understood a person's dreams, one would know not only his past, but also how he intended to deal with his present, and thereby influence his future.

Part of a dream related by a friend of the writer's may illustrate this:

> "From the bank of a rapidly-flowing river he rowed himself into mid-stream. A friend on the bank thought it dangerous, but the dreamer knew that what he was doing was right, and woke up saying a phrase from the Bible, which was then forgotten."

On analysis the river, the friend, and the scenery of the dream were all accounted for in terms of his past experiences. Before going to sleep he had read of a person who, having lived an uneventful life, dreamt that she was surrounded by stagnant water. The day before the dream he had joined the staff of a modern hospital for psychotherapy,[1] and had remarked to a friend that life there seemed to pass at ten times the rate that it had done in his lonely private practice, and that here, as of old, the doctor's functions seem to be merged with those of the priest; for, "Here," he said, "it is possible to save souls." And at this point in the analysis there flashed into consciousness the Scriptural phrase which he had uttered on awaking. It was "fishers of men."

Of such a dream it seems undoubtedly true to say that, whatever it may derive from the dreamer's past, it undoubtedly illuminates his conception of his present and his future.

To regard psychology as the mere description of conscious states is to pay attention only to the surface of experience. And in the modern exploration of the depths of the mind, no light has proved more penetrating than that which comes from Freud's pioneer discoveries. By the analysis of dreams, and by similar analytical methods applied to symptoms, it has already been possible to discover the hidden causes of many nervous and mental disorders. The value of Freud's work to medicine, however, must not blind us to its importance for general psychology. For it has already altered the whole outlook, and probably the whole future, of this study.

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[1] *Journal of Mental Science*, 1910, vol. lvi, p. 443.

[1] That is, the psychological treatment of mental cases.

BOOKS SUGGESTED FOR FURTHER READING

On Dreams, by S. Freud. (London.)
"Freud's Theory of Dreams" in *Papers on Psycho-analysis*, by Ernest Jones. (London, 1918.)
The Meaning of Dreams, by I. H. Coriat. (London.)
Dreams and Primitive Culture, by W. H. R. Rivers. (London, 1918.)
Dream Psychology, by Maurice Nicoll. (Oxford.)

The British Academy, at the invitation of and in conjunction with the Palestine Exploration Fund, and with the concurrence of the Foreign Office, have appointed a strong Committee for the purpose of establishing a permanent British School of Archæology at Jerusalem. The objects of the School will be: (1) To facilitate the researches of scholars; (2) To provide instruction and guidance for students; (3) To train archæological excavators and administrators. The School will assist in every possible way the excavations and explorations of the Palestine Exploration Fund. The scope of periods and subjects of study will be unrestricted, ranging from the Stone Age and the early civilisations of Amorites and Canaanites through all the history of Palestine and Syria, and their relations with the nations around them, down through the Græco-Roman Age to the Arab Conquest, the Crusades, and the later Mohammedan period.

Discovery and Education

By A. L. Smith, M.A.

Master of Balliol College, Oxford

The war has presented us with three discoveries in the sphere of education. We have found in the first place that war could be a great education, and this in the most literal sense; that war training and war itself could produce not merely improvement in physique and strengthening of character, but also could and often did—and this was the surprise—develop the actual powers of the mind. This should not have been a surprise; for, after all, education is only the development of the power of thinking, and as more than one young soldier has found, "You have to do a lot of thinking in the trenches."

Long ago, in the infancy of democracy, it was said, "Now we must educate our masters." Now that the people are very manifestly our masters, the need is still more manifest. "What! a burning desire for education, true education, that is a love of knowledge for its own sake or for the still higher sake of fitting the student to serve his country! Can there be such a widespread passion now among the masses?" This question has been so put by a sceptical journalist. He may receive some enlightenment if he consults the evidence in the *Report* just issued by the Committee on Adult Education (Cmd. 321), or if he inquires into the experiment of the Army Camps in the last two years. This has been the second discovery. But (to quote the journalistic critic again), assuming the desire, is there the capability among the masses? Here, again, the answer comes from practical experience, experience summarized in the *Report*. It is true that the thoughtful and studious, who will naturally lead the opinions of their fellows in mine, factory, or shop, can never be more than a few thousands. But these thousands are a leaven; they are more in number than could have been guessed; that number is capable of rapid and immediate expansion; and outside these more select students, there is a far greater circle of adult men and women capable of far more than we imagined in the way of intellectual interests. Till this war we undervalued the military value of the rank and file of our people because we did not realize their moral capacity. Do not let us go on undervaluing their intellectual capacity; for the discovery of this has been the third educational discovery of the war.

The Government Committee on Adult Education, which has been sitting for two years and has just produced its *Final Report* (Cmd. 321), found that these three facts were implicit in the experience we already had before us. It found also that Adult Education was not a mere phrase or fad, or even a superfluous luxury, but an absolute necessary of the nation's future social and political life. In this we might also learn from the enemy. The Germans pronounced us a profoundly uneducated people who knew no foreign languages, worked short hours, substituted "good form" for efficiency, depreciated teachers, had no respect for knowledge, were given over to sport and games, holidays and "week-ends," not to mention strikes and drink. The Germans used to declare that it was their schoolmasters that won them the wars of 1864, 1866, 1870; and they certainly showed in this war what formidable strength can be produced by a universal, scientific, systematic instruction resulting in an extraordinary unanimity of national aim, and an undeniable capacity of sacrifice for an ideal.

True, the German machine lacked variety, buoyancy, and individual initiative, qualities which only grow in an atmosphere of freedom. What we have to learn is how to combine freedom and individual initiative with a more efficient system and organization. Only thus can we face our present problems, which all come back to better education as their basis and demand. Thus world-peace depends in the last resort on the proportion of intelligent citizens, British and American, that appreciate the danger, and are willing to meet some corresponding obligation. Or, if we take the Imperial position, it has to be readjusted to two opposing facts, the determination of the Dominions to have a say in the future before going to war, and their equal determination to submit to no diminution of their own autonomy. How can these be reconciled but by a public opinion educated out of its mistrust of the term Empire, and educated up to the vast potentialities implied in a World Commonwealth?

Then there are our home problems. Is the State to buy up mines, railways, "the trade"? Can Democracy get its will really represented, or must it have recourse to "direct action"? How is "Labour Unrest" to be turned into industrial harmony without a better understanding on each side? Is the tremendous question of women's standing as industrial competitors against men, with its incalculable results on family life and sexual morality, to be settled by an uneducated generation? Or, to deal honestly yet wisely with the two cankers of our society, drink and prostitution, can we trust to anything but the education of that social conscience which is now so callous? The politicians will not take up these problems till there is a public demand, and that means a more enlightened public—in other words, the extension of a true education into adult life.

The first step is to attack the obstacles which now hamper adult education, such as excessive hours of labour, fatigue,—whether due to monotony or to unduly exhausting work—insecurity of employment, lack of holidays. On all these conditions the workers themselves are coming to be acutely conscious. They realize that modern industry tends to become more and more mechanical, that it provides less educational interest in the work itself, and offers little opportunity to satisfy intellectual, social, or artistic impulses. They demand "industrial control" on the ground that industrial democracy is as essential to individual freedom as is political democracy. Present social conditions also stand in the way. Inadequate housing, (nearly half the population living more than one to a room), squalid surroundings, low wages, especially in rural districts, lack of village halls or public rooms—all these create a vicious circle to which the women are tied down even more than the men. These conditions call for reform on moral and social grounds; while it is obvious that they are vicious also on economic grounds. For no one can doubt that we are at a turning-point in our national history. A new era has come upon us. We cannot stand still. We cannot return to the old ways, the old abuses, the old stupidities. As with our international relations, so with the relations of classes and individuals inside our own nation; if they do not henceforth get better, they must needs get worse, and that means moving towards an abyss. It is in our power to make the new era one of such progress as to repay us even for the immeasurable cost, the price in lives lost, in manhood crippled, and in homes desolated.

Only by rising to the height of our enlarged vision of social duty, can we do justice to the spirit generated in our people by the long effort of common aspiration and common suffering. To allow this spirit to die away unused would be a waste compared to which the material waste of the war would be a little thing; it would be a national sin, unpardonable in the eyes of our posterity. We stand at the bar of history for judgment, and we shall be judged by the use we make of this unique opportunity. It is unique in many ways, most of all in the fact that the public not only has its conscience aroused and its heart stirred, but also has its mind open and receptive of new ideas to an unprecedented degree.

It is not the lack of goodwill that is to be feared. But goodwill without mental effort, without intelligent provision, is worse than ineffectual; it is a moral opiate. The real lack in our national history has been the lack of bold and clear thinking. We have been well-meaning, we have had good principles; where we have failed is in the courage and foresight to carry out our principles into our corporate life.

This corporate life itself has only been made visible and real to us (as on a fiery background) by the glow and illumination of the war. We have been made conscious that we are heirs to a majestic inheritance, and that we have corresponding obligations. We have awakened to the splendid qualities that were latent in our people, the rank and file of the common people who before this war were often adjudged to be decadent, to have lost their patriotism, their religious faith, and their response to leadership; we were even told they were physically degenerate. Now we see what potentialities lie in these people, and what a charge lies upon us to give to these powers free-play. There is stirring through the whole country a sense of the duty we owe to our children, and to our grandchildren, to save them, not only from the repetition of such a world-war and from the burdens of a crushing militarism, but to save them also from the obvious peril of civil dissension at home. We owe it also to our own dead that they shall not have died in vain, but that their sacrifice shall prove to have created a better England for the future generation.

Though education in this sense was so vital a need, yet the ordinary Englishman had never realized it. He regarded it as a subject inherently dull and dry, because it was too "bookish," too much absorbed in the technique and mechanics of the art. It was "finished" at about eighteen. Indeed, for the mass of the population education finished before fourteen, and naturally education which ceased then was forgotten before eighteen. The mass of the eighteen-year-old recruits were found unable to write a simple letter, unable to do a simple sum, and hardly able to read even the simplest book; but with the new Education Act, adult education starts at a new level, and also demands wholly new methods. It must begin with the existing avocations and interests of the youth, to show the reasons that underlie his daily work, the relation of his work to that of others, and its place in the service of the nation and of the world. In the Army Camps from February 1917, recruits of eighteen from the woollen district might be seen learning where the different kinds of wool come from, what has been the history of the industry, what are the qualities which make wool the best clothing, what mechanical means are used on it, and what principles are embodied in the machines in wool-factories; and so in other cases we have to begin not with abstractions but with the concrete objects, and work back to the *rationale* of them.

To see all this coming out of the army was like a modern version of Samson's riddle: "Out of the eater came forth meat!" Mr. Fisher, indeed, has said, with one of his happy audacities, that it is a new departure as epoch-making as was gunpowder in military history. For a whole group of discoveries are involved in it; that a modern army may be the means of training a whole population in that physical efficiency and mental alertness which are now seen to be, more than mechanical drill and discipline, the essential things in modern warfare; that part of this training may make the recruit a better man at his own future craft, more of a "handy man," and a more efficient military unit; that alongside there may be, as there should be, a training in the elements of citizenship so that the recruit gets at least some idea, (*a*) what his nation is, and what it stands for in its past history and literature, and what is its place among the other nations of the modern world; (*b*) what are his duties to it, from the elementary duties of sharing in its defence and submitting to its laws, up to the duty of helping to maintain and even to elevate its standards and ideals; (*c*) what are the economic, political and international conditions on which his nation's efficiency and well-being depend, its relation to the other constituent parts of the Commonwealth of British nations called the Empire, and the degree to which it can now or in the future enter into closer relations with other civilized nations for the just treatment of less developed races, for the furtherance of international co-operation in science, medicine, law, commerce, arts, and for the increasing establishment of world-peace.

A future age surely will wonder that modern nations, which had in their conscript armies the whole of their youth during those plastic years eighteen to twenty-one, made no use of this unrivalled educational opportunity, even from the narrow militarist point of view.

It is not commonly realized what a great mass of efforts went on through the nineteenth century to build up some system of higher education suitable to the needs of adult men and women. These efforts drew their inspiration from different sources—religion, science, politics, economics; many movements contributed, such as Chartism, Co-operation, Trades Unionism. But all the earlier efforts, till after 1870, were hampered by the absence of a general elementary education. Even then there was still the gap of the years from fourteen to eighteen; now that this is to be filled up, there will be great expansion. Already the standard of the work done, according to the report of the Board of Education Special Inspectors, among the best students, compares favourably with the best academical work; they are fit to read for the Oxford Diploma in Economics, and would obtain it without difficulty. Is it not remarkable to find such results among students who have had no education since fourteen, who at first can only read a book with excessive slowness, and can hardly put down their thoughts on paper at all? Is it not an interesting discovery to find that the school of life can do as much for mental training as a definite college course? These most recent efforts have all sprung from the workers themselves, and the Workers' Educational Association, thirteen years old, now comprises 219 branches, 2,525 affiliated societies, and over 17,000 members. The highest point reached is in the Tutorial Classes, in which each student pledges himself for three years; the total number of such students in the year before the war was 3,234. These classes are already showing signs of rapid development. In one industrial district with an adult population of 400,000, the number of students attending Tutorial Classes, One-year Classes, and Extension Classes was over 7,000. There are institutions such as the Working Men's College, with its 3,939 students. The total numbers included in some form of adult education consist of an appreciable fraction of the population of the country; and the movement is only in its infancy.

There are important lessons to be learnt from these facts. The first is that real education can often be begun again in adult life. The next is that such education should start from the facts which are already part of the learner's familiar experience. The third lesson is that this method, by its freshness and actuality, supplies a new inspiration to the teachers themselves. The fourth lesson is that manual work itself may be so treated as to be a vehicle both of culture and of mental training. The defects in adult education as it stands at present are that too often it is discontinuous; there is apt to be undue reliance on lectures, and not enough class work and personal effort, not enough personal criticism and individual tuition; the teachers are too few, and hence get overworked; and there is not an adequate supply of books. But these defects are all curable, and that not at great cost; and adult education, like other forms of higher education, can never be completely self-supporting. It must always depend largely on voluntary effort and spontaneous enthusiasm, particularly now in its pioneer days; but it ought not to be asked to live wholly on this its precious capital. The Trade Unions and the Co-operators ought to help more than they do, but so too should the Universities and, above all, the State.

The Theory of Relativity. By H. L. Brose. (Blackwell, 1*s*. 6*d*. net.)

A description, in about nine thousand words, of this interesting and fashionable subject. It is dealt with non-mathematically, and written so that anyone with a scientific training can get hold of the salient points in the theory, and follow out the successive stages of its development.

References are given to the standard works on the subject, so that this pamphlet may well serve as a starting-off point for interested readers.

Pioneers of Progress: Herschel, by HECTOR MACPHERSON; *Joseph Priestley*, by D. H. PEACOCK. (S.P.C.K., each, 1*s*. net paper; 2*s*. net cloth.)

Concise and straightforward descriptions of the lives of these two pioneers.

The Conference of Paris

By J. W. Headlam-Morley

By the time that these words appear in print, it is probable that the Treaty of Peace with Germany will have been ratified, and within a few weeks the Congress of Paris will have come to an end. It will take its place in the history books, with the Congress of Utrecht and the Congress of Vienna, as one of the great landmarks in European history, and it may be interesting to take this opportunity of considering its work and its achievement from the point of view of the student and teacher of history.

It is natural to compare the Congress of Paris with the Congress of Vienna, and I fear that, in the minds of many, the result of the comparison has been, as it was expressed to me by a great scholar: "I think we are all beginning to think better of the Congress of Vienna." I am quite sure that those historians who took part in the Conference of Paris—and there were several—will be, shall we say, a little less severe when they have brought practical experience to the criticism of the deeds of our predecessors. But if we are to make the comparison, let us recognize at once that Paris had difficulties to meet from which Vienna was freed.

In the first place let us note that, as compared with the Congress of Vienna, that of Paris had imposed upon it a double task. In 1814 there were two things to be done, first to settle the terms of peace between the Great Alliance and France, and secondly to settle the numerous questions which arose as to the assignation of that territory which, after being surrendered by France, was left derelict. These two stages were clearly separated. Peace was made with France at Paris within a few weeks of the termination of the war, and it was possible, therefore, for the Powers of Europe to apply themselves in comparative leisure to the other problems. In 1919 a different procedure was adopted; the whole settlement of Europe had to be made under the form of Treaties of Peace, and the settlement between the Allies themselves, a settlement in which inevitably strong differences of opinion must appear, had to be made while the state of war still continued. It is curious to note that this was probably not the original intention; at any rate, throughout a every large part of the Congress, all the papers were headed "Preliminaries of Peace," a style which seemed to indicate that the original intention had been first of all to make general preliminaries of Peace with Germany, and afterwards to proceed to more detailed regulation of minor and secondary points.

Another difficulty arose from this procedure—viz., that direct communication with the enemy Governments was excluded. A study of the text of the treaties will show that they deal, often in great detail, with matters of great complexity; this is especially the case in the chapters dealing with financial and commercial matters. Merely as a matter of procedure, the work would have been much facilitated had it been possible to discuss these matters around the table with the German Delegates; the possibility of this was, however, excluded.

Another result was that there was thrown upon the Conference, not only the task of making peace, but the even more serious task of controlling the affairs of Europe during the process. What had to be done for the temporary administration of those districts whose ultimate fate had to be determined? Many of these were the subject of acute controversy between our own Allies, and this threw upon the Conference the responsibility of keeping order in these disputed territories, and at times even preventing open hostilities between the Allied States themselves. Let us add to this that the very progress of civilization has added immensely to the complexity of the problems which had to be dealt with. In 1814 there were no railways; in 1914 the problem of transport forced itself upon the attention in two different ways. First of all the daily life of millions of people in Europe depended upon the provision of adequate means of transport, and, secondly, it was impossible to determine the frontiers without taking into consideration the lines of communication. If the frontier had to be drawn between Poland and Germany, or Czecho-Slovakia and Poland, or Italy and Yugo-Slavia, it was necessary so to arrange it, as not only to comply approximately with the nationality of the population, but also so as to insure that there should be no undue interference with the control of the main lines of railroad.

It is therefore little to be wondered that the work thrown upon the Congress was almost beyond human capacity. It was on the Council of Four that the stress of the labours rested, and I wonder sometimes whether those who criticize the result have ever tried to imagine what the extent of the labours and the measure of the responsibility was, which attached to these men. Day by day, and week by week, they had two meetings, one in the morning and one in the afternoon, at which there would be brought up to them for their final decision, now the question of the frontiers between Poland and Germany, or Czecho-Slovakia and Hungary, and the future of the Banat, or Teschen, or Klagenfurt, or Danzig, and then, with scarcely a moment's pause, complicated questions as to the treatment of enemy debts, with the determination as to the rate of exchange at which they would be fixed, what was the extent of the reparation which could be imposed upon Germany, and in what form and by what machinery it should be exacted, the determination as to international control of the waterways of Europe, the conditions which should be attached to the recognition of new States, such as Poland or Czecho-Slovakia, the innumerable questions which arose out of the liquidation of the Austro-Hungarian Monarchy; and all the time there pressed for immediate decision matters of urgent practical policy, such as the attitude that should be adopted towards the claims for autonomy or independence of the Baltic States, the relationship towards the Bolshevik Government in Russia, and the help, if any, which should be given to the forces of Kolchak and Denekin, the method of establishing the control of the Conference over the insurgent populations in East Galicia, and, at the same time, the steps necessary for carrying out the conditions of the Armistice with Germany. To those who look back on the multitude and rapidity with which problems of this kind came up, it may be a matter of surprise, not that from time to time decisions were made which have not commanded universal consent, but that the work was done at all.

But perhaps the most striking difference between Paris and Vienna arose out of the peculiar nature of the terms of the Armistice, in which were specified the general principles in accordance with which the peace was to be made. Germany had laid down her arms and the Allies had agreed to an armistice on the condition that the ultimate peace should be in accordance with certain principles which had been stated by President Wilson. These are generally referred to as the "Fourteen Points," but it is worth while remembering that they were, in fact, not limited to the fourteen points specified in his speech of January 1918; there were also included in the correspondence preceding the Armistice a reference to any later statements that he made. In fact, the other statements which he made comprised four other lists of points placed in a categorical form, and made in subsequent speeches or official messages. It has been stated that the Conference completely ignored the Fourteen Points, that they were not considered. This can be emphatically denied. Each individual can, of course, only speak as to his own personal experience, and this is necessarily limited to those parts of the discussions with which he was immediately concerned. I may at least be allowed to record my own experience. It is that throughout the discussions there was constantly present to the minds of those who took part in them, and frequent reference made to, the Principles of the Peace, and I can affirm, on immediate and personal knowledge, that in the Council of Four itself the decision on matters of the highest importance was determined by explicit reference to the Fourteen Points—e.g. a decision favourable to the Allies, and for which there were many grounds of expediency, would be rejected solely because it could not be reconciled with the pledges which had been given. But the Principles by which the work had to be guided had not been expressed in a manner which made their translation into precise legal form easy; to a large extent they were general conceptions, aspirations, exhortations, and some of them were not easy to reconcile with one another. Let us take one of the four points in President Wilson's address to Congress of February 11, 1918: "All well-defined national aspirations shall be accorded the utmost satisfaction that can be accorded them without introducing new, or perpetuating old, elements of discord and antagonism, that would be likely in time to break the peace of Europe and consequently of the world"; and another, in the same speech: "Each part of the final settlement must be based upon the essential justice of that particular case, and upon such adjustments as are most likely to bring a peace that will be permanent." To these dicta all might give assent, but the application is not without difficulty. How are we to accord utmost satisfaction to the well-defined national aspirations of the Poles or the Czechs or the Yugo-Slavs, without introducing new or perpetuating old elements of discord and antagonism? And how are we to define what is the well-defined national aspiration? Are the claims of the Ruthenians of East Galicia, or the Wendish inhabitants of Lusatia, or the Lems of the Carpathians, to receive recognition under this formula? And how are we to balance the historic claims of the modern representatives of the old Polish and Bohemian State against the rival claims of ethnographic frontiers? East Prussia had been Polish land to the time of the Partitions; then it became Prussian, and since then there has been a large German infiltration of population. If we assign this territory to Poland, East Prussia will be separated from the rest of Germany; if we assign it to Germany, Poland will be cut off from the sea, and a large Polish population continue under German subjection. Where is justice, which we all seek, to be found? The settlement with Germany has been widely criticized on the ground that it is incompatible with the Fourteen Points; I venture to think that, on territorial points, the more impartial judgment of the future will be that, in face of problems of unexampled difficulty, the greatest effort was used to find a settlement which would be in accordance with the principles of the Treaty. No purely and undoubtedly German territory is to be separated from Germany, and where there was a reasonable doubt as to the affinities and wishes of the population, it has been determined that they themselves shall be consulted as to their future allegiance, as in Upper Silesia or in the district of Mazuria.

It is the first time that in a great European settlement the population of doubtful territories have had the opportunity of giving their own vote. This principle had, indeed, been adopted at the time of the French Revolution, and received its most emphatic sanction in the time of Napoleon III, first in the creation of the United Kingdom of Italy, and secondly in the transference of Nice and Savoy to France. The conception of the plebiscite is a principle which it is easy to accept, but the application of it presents great difficulties and dangers, and it was not unnatural that the Conference should use it only in those cases where it was absolutely inevitable; for a plebiscite means prolonged uncertainty, the continuation of national animosity and allied occupation.

Sound-Ranging in War Time

By A. S. Russell

SOUND-RANGERS were a body of men who, in the late war, spent their time and energy in locating hostile batteries accurately, in estimating the number of guns or howitzers in such batteries, in ascertaining the calibre of these guns, and, on occasion, in assisting certain portions of the Royal Regiment of Artillery in "strafing them to blazes." This they did, these sound-rangers, not by guess-work or intuition, or by bluff; they had a system, and the whole system, method, apparatus and procedure goes by the name of Sound-Ranging.

At the bottom of the whole matter is the fact that sound travels, not quickly like light or electricity, but at a comparatively leisurely pace—namely, about 370 yards a second in air at ordinary temperatures. Suppose, now, that a loud noise as, for example, an explosion, occurred at some particular spot in South London, the report would reach Londoners at various times after the explosion had really occurred, depending upon their distance from the place where the sound came from—the sound travelling in every direction at equal rate, at about 370 yards per second, neglecting the (very slight) influence of the wind. If an observer on the Monument heard the explosion at exactly the same time as one on the tower of Westminster Cathedral, it is obvious that, wherever the sound originated, it did so at a place that is equidistant from these places. If, however, we suppose the observer on Westminster Cathedral heard the sound exactly one second before

[*Continued on p. 20*

BELL'S LIST

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the observer on the Monument, then it follows that the origin of sound must be at some point which is about 370 yards nearer the former place than the latter.

The number of places in London which are this distance nearer to Westminster Cathedral than to the Monument is legion, but, if we mark all such points on an accurate large-scale map, it is found they all lie on one curve; and, further, if the place where the sound began is more than three miles away both from Westminster and the Monument, the curve may be taken as a straight line without any appreciable error. This simplifies matters enormously. With two points of observation, therefore, knowing exactly how soon the sound arrives at one before the other, we have information enabling us to draw on a map a straight line, some point of which is the place we want to find out.

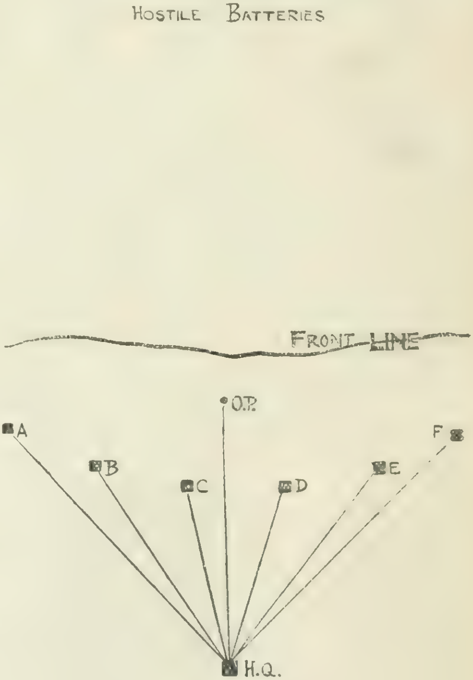
We shall now suppose we have a third observer, and we shall place him in the window of a certain house in Chelsea. He hears the noise of the explosion, we shall suppose, exactly half a second after the man on Westminster Cathedral. If follows that the source of sound must be about 185 yards farther from him than from the man at Westminster. With this fact before us we are enabled to draw a second line on our large-scale map of London, every point of which is 185 yards nearer Westminster Cathedral than the house in Chelsea. This line intersects the first one somewhere. That somewhere is the only point which is common to both lines, it is the only point in South London which is *both* 370 yards nearer Westminster Cathedral than the Monument, and 185 yards nearer the latter than the house we selected in Chelsea. That is the point where the sound originated.

To locate a sound, therefore, we require to get possession of such facts as will enable us to plot on a map at least two curves. For this we require three places of observation. If we had six places of observation we should obtain data for five curves, and if these all intersected at one point, as in general they would, we should be inclined to feel surer of the point we were trying to locate, than if we had merely an intersection of two lines. Similarly, if we had a hundred places of observation, and measured the differences in time between a sound arriving at these, we should be enabled to draw ninety-nine curves. Accuracy in locating sounds, however, does not depend upon having a host of observation-stations, but, other things being equal, upon having these stations as widely separated as possible.

When the French Army (they were the pioneers in this work) discovered that this simple scientific principle might be used with advantage in locating hostile batteries, they commenced experiments. This was done in October of 1914, when it looked as though the fighting in France was going to settle down to trench warfare. Their work was so successful and promising that the British took it up, and a year later an experimental sound-ranging section set to work at Kemmel Hill, just south of the Ypres Salient. This unit developed the work in its own way, both scientifically and tactically, and in 1916 each army of the Expeditionary Force on the Western Front had two of these units assisting the Heavy Artillery. In 1917 and 1918 there were more than thirty sections working on the Western Front, and a few in Salonika and in Palestine also.

The original officers were men trained in physics who happened to be serving with their infantry or artillery units in France or at home in 1914-15. Sound-ranging, therefore, never ran the risk of becoming an ultra-scientific series of pretty experiments, of interest to research workers alone. It developed into a system of real tactical value.

A sound-ranging section consisted of four officers and about forty men. The disposition of their headquarters, and their sound detectors, with regard to the front line, is shown in the figure. The personnel lived



at the spot H.Q. about four to six thousand yards from the line. Here the whole of the apparatus for locating the hostile batteries was kept except the six sound-detectors, or, as they are also called, the microphones. One of these instruments was placed at each of the points A, B, C, D, E, and F, which points were usually from three to five thousand yards behind the front line. Each of these points was carefully surveyed so that its exact position on the map was known. Usually it was arranged that the six points were at intervals of about a mile, and lay on a circle, the centre of which was inside the enemy's lines at about the average distance back of the enemy's heavy artillery. This was done merely for convenience, and is not a necessary element in locating the batteries. The sound-detectors at each of these six points were connected up with the recording apparatus at H.Q., by wires, just as though they were telephones. It was found that it was much better in every way to detect the report of a German gun with an apparatus than by the ear of a man. The very instant the sound was heard at B, for example, the fact was instantaneously communicated along the wires to H.Q., where it was recorded. If a man, however, was observing, a time of one-twentieth to a fifth of a second would elapse between his hearing the sound and his pressing a button to record it, depending upon his experience and his natural quickness. This is a very interesting fact in experimental psychology, but in sound-ranging it led to inaccuracies. A sound-detector, specially designed by one of the officers, was therefore used instead.

There were observers, however, at the observation post, marked O.P. Their duty was to listen, and to observe. When a German gun or howitzer fired, one of them pressed a button as soon as he heard the report. This had the effect of starting up the whole of the recording apparatus at H.Q. A few seconds later the report of the gun would be heard by the microphone which was nearest to the battery firing, then by the second nearest, and so on till all had heard it. When the observer considered that the sound had passed over all the detectors, he ceased pressing his button, and so stopped the recording apparatus working. This remained quiescent until the German battery fired again. The observer next telephoned to H.Q., in cheerful tones, the direction from which the sound of the enemy gun had come, his idea of the size of the shell, and, when he could see what the enemy were trying to hit, the approximate location of the target. All this information is very valuable to the men at H.Q., whose job it is to work out the location accurately.

I have said the forward observer at O.P. controls the recording apparatus at H.Q. This observer is sufficiently in front of the line of detectors to hear most

[*Continued on p. 22*

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gun reports two or three seconds before any detector can. During this interval he has started up the apparatus, and it is running merrily and is ready to record. As each detector gets the sound, a little wire at H.Q. gives a jerk, and the moment of this jerk is recorded by photographing these wires on a moving film. Everything is so arranged that simultaneously the time intervals between these jerks are recorded on the same film accurately to one-hundredth part of a second.

When the apparatus stops, the film is developed and fixed in about ten seconds, and handed to a computer, who obtains from it the time intervals between the signals. These intervals are, of course, the differences in time between the sound of the gun arriving at the six detectors. These give him five time differences—namely, the differences between the sound arriving at A and B, B and C, C and D, D and E, and E and F. From these five differences, after correcting for temperature and wind, he gets his five lines, from the five lines his intersection on the map, and the point of this intersection very approximately is the enemy gun. This location is at once telephoned to the Heavy Artillery, who immediately take such action as they consider fit. The sound-ranger's work is diagnosis. He says where the offending battery is, whether or not it is very active, what place it is trying to hit, and so forth. Our artillery supply the remedy.

The accuracy of sound-ranging locations could be tested in several ways. The results could be compared with those obtained at the same time by other sources, as, for example, by the observations of R.F.C. pilots during the day, and of "flash-spotters" by night. Secondly, the locations could be checked by comparison with air photographs. This was most easily done when some sign of an emplacement or of a battery position was visible on the photograph. The third and most convincing check was an examination of the former German battery positions after an advance had been made into their territory. Fifty yards was about the mean error made in a sound-ranging location under normal circumstances.

A sound-ranger's life on a quiet front was a happy one. On such fronts there was little enemy firing, and the enemy did not move his batteries more than he could help. The sound-ranging locations, collated with evidence from air-photos and flashes at night, led in general to the discovery of the exact positions of the batteries.

Very rapidly the special stunts, habits, and even idiosyncrasies of each battery were known. They became quite old friends. Such friends had a rough time of it. As soon as they had opened fire, and in due course been located, they were fired on by our artillery. Anyone who knows about artillery firing will appreciate the difficulty and expense of "knocking-out" a hostile battery, but it was comparatively an easy matter to "silence" or "neutralize" it—that is to say, in plain English, to make it stop.

On such fronts, in addition to his normal work of locating batteries, the sound-ranger could also "observe" for the Artillery, if by "observe" we mean here directing fire, not by looking at where the round fell, but by listening for its burst. A great deal of this work was done for our Heavy Artillery in 1917 and 1918 on all except the extremely noisy or battle fronts, and much valuable aid was thereby given them. A numerical example will help to make clear the method by which this was done. Suppose a German battery fired from such a position that its report arrived at the detector at A first, then half a second later at B, then one second later than that at C, one and a half seconds later than that at D, two seconds later than that at E, and two and a half seconds later than that at F. Suppose next that from these time differences the sound-ranging section has located the position of the offending gun. One of our own batteries, a 6-inch, an 8-inch, or a 9·2-inch howitzer battery, was then called up from H.Q., and asked to fire on the located point. In due course the round was fired and exploded in enemy territory. This explosion was now located just as though it were a gun report. Now, if this noise arrived at B after A by exactly half a second, at C after B by exactly one second, at D after C by one and a half seconds, and so on, then it is obvious that this sound must have come from exactly the spot where the gun report originated. In plainer terms, the hostile battery has suffered a direct hit. This, of course, would be a rare occurrence with the first round. Ordinarily the time intervals recorded for the burst would differ somewhat from those of the German gun, but knowing these differences, by means of a "gadget," the computer could tell at once how far over or short of the target, or how far right or left of it, the round fell. The correction was sent to the gunner, and the British gun continued firing and being corrected till the record of the burst coincided with, or approached as nearly as possible to, the original record of the hostile gun.

This method of ranging was most conveniently used when the usual kind of observation, whether by aeroplane or ground observer, was impossible, as, for instance, at night or at dawn, or on dull, foggy afternoons. None the less it could be extremely accurate work, and this accuracy could be tested by photographing from the air, subsequent to the shoot, the neighbourhood of the battery fired on, and comparing the positions of the shell craters with the points where the sound-ranger said the rounds fell.

On busy, noisy, and battle fronts, the work of the sound-ranger was more difficult, partly because of the row due to our own artillery, and partly to the cutting of the wires connecting the sound-detectors with Headquarters. He had to do his best in difficult circumstances, get his wires mended under fire, wait for lulls or night-time, and work hard then. It is a great mistake, however, to conclude that even on busy fronts the guns of both sides were firing all the time. Conditions were not always adverse, and by experience, hard work and resource, the location of the batteries by sound could be effected.

Like most scientific work used for tactical purposes in the war, sound-ranging, both as a strictly scientific study of the vagaries of sound, and as an instrument for helping on our side, showed steady improvement in method and in utility right up to the Armistice. This was due to the splendid co-operation between the powers that be and the experimental sound-rangers at General Headquarters, and between the Heavy Artillery and the routine sound-rangers up the line.

NOTE.—For further information on this subject see *Nature*, November 13, 1919, p. 278.

Spitsbergen

By R. N. Rudmose Brown, D.Sc.

Lecturer in Geography in the University of Sheffield

ALTHOUGH the discovery of Spitsbergen is generally attributed to the Dutch in 1596, it is quite probable that the Norsemen knew it earlier under the name of Svalbard. Possibly, also, Russians knew it before the Dutch discovery. Early in the seventeenth century British, Dutch and Danish walrus hunters and whalers began to visit it in great numbers. When they fell off owing to the partial extinction of their prey, Russian trappers from the White Sea began the habit of wintering in Spitsbergen in search of bears, foxes, and reindeer. At a later date Norwegians supplanted the Russians and almost exterminated the game. However, in spite of all this activity and the visits of many exploring expeditions—British, Swedish, Russian, and later Norwegian—much of the country is still unexplored, and comparatively little, even of the coasts, is accurately mapped.

There is still some winter hunting in Spitsbergen, but at present the country is attracting attention on account of its mineral wealth. The first coal bed was found about 300 years ago; since then many other seams have been discovered, but before this century no attempts at coal-mining were made. Whalers and hunters occasionally used the coal from time to time,

[*Continued on p. 24*

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and exploring vessels, short of fuel, have replenished their supplies on some occasions. Coal was not the first mineral to bring miners to Spitsbergen. As long ago as 1872 an unsuccessful attempt was made to dig phosphates by a Swedish company. It was, however, a British company which began coal-mining in 1904. Their mine was near the mouth of Advent Bay, and there grew the first timber village in Spitsbergen. For various reasons the mine was abandoned after a few years. In 1904 Americans also came on the scene, purchasing from Norwegian owners an estate in Advent Bay opposite the English mine. Longyear City, as they called their camp, grew in a few years' time to a settlement of several hundred miners living in log houses. It is still the unofficial capital of Spitsbergen, and its wharf in summer is seldom without a steamer loading coal by the wire ropeway from the mine. The success of the Americans brought a host of prospectors to Spitsbergen. They planted their claim boards on every shore, as often as not ignoring previous claimants. In districts where coal was known to occur the claim boards were most frequent, but quite valueless shores had their share of them. No attempt was made to develop most of the estates beyond the construction of a few prospectors' huts. As often as not the so-called "prospectors" were quite unqualified for their task. In those days Spitsbergen was beyond the sovereignty of any nation: no State had the power to enforce its laws. There was no satisfactory system of registering claims, and no court of arbitration or appeal. Anarchy reigned, and each claimant had to watch and protect his own interests, but except for the insecurity of property, the system or want of system worked well enough. The absence of taxes, mining dues, etc., had its advantages.

It was, however, due to the war that Spitsbergen mining really progressed, and incidentally that Spitsbergen ceased to be a no-man's land. During the years of war, development work on British claims was perforce in abeyance, but it made great strides on Norwegian and Swedish estates. This was due to the high cost of coal and its great scarcity in Norway and Sweden. Scandinavians worked with feverish energy to extract as much coal as possible in Spitsbergen before the price of coal fell. The American coal-mine was bought by Norwegians, two new Norwegian mines and a Russian mine were started, and a Swedish mine revived. As soon as the war was over the two British companies owning land were again at work on their estates. One of them last summer not only located a new coal-field and begun its development, but discovered large deposits of good iron-ore on Prince Charles Foreland, the most westerly island of the group. At present five mines in Spitsbergen are exporting coal; this number will soon be increased. The total coal export has risen from 35,000 tons in 1913 to close on 100,000 tons in 1919; in a few years it should be over 250,000 tons. Even this will be insufficient to supply Norwegian ports between Narvik and Vardö, to say nothing of the demands of the Russian ports of Murmansk and Arkhangel.

Although in the Arctic regions, Spitsbergen is really part of Europe. It is only 400 miles from Norway, and 1,300 miles from the Firth of Forth. Spitsbergen—which has an area about equal to that of Scotland—includes one large and a number of smaller islands. The distant Bear Island and Hope Island are generally included. The mainland of Spitsbergen is deeply indented on the west by long, branching fjords: Icefjord, Bell Sound, King's Bay, and Smeerenburg Sound are names of frequent occurrence in the long and adventurous story of Spitsbergen. Narrow strips of plain fringe some of the coasts, and are crossed by glaciers flowing to the sea down the valleys of the ranges. For the most part the country is very mountainous, but few peaks rise to more than 3,000 or 4,000 feet. Almost everywhere the surface of the land is rough and rocky, or covered with swamps, but several levels of raised beach around the coasts afford natural highways and building sites of great value in the present phase of Spitsbergen's development.

In winter the temperatures are low, the snow-line descends to sea-level, and the coasts are generally ice-bound, but in summer the conditions are very different. The warm Atlantic drift and the prevailing south-westerly winds not only keep the western coasts open and free from ice from May or June to October, but cause comparatively high temperatures. The result is that the west coasts are easily accessible throughout the summer by ordinary vessels, and all the lower ground is free from snow. The continuous daylight adds to the charm of summer in Spitsbergen. Vegetation is scanty, and there are no trees. Patches of bright-coloured flowers, however, are not infrequent, and mossy bogs are numerous. The animal life includes reindeer and foxes throughout the year, and polar bears in winter when the pack-ice comes south. Bird life is abundant, many of our well-known birds going north to Spitsbergen to breed in summer: but in winter the ptarmigan or some wandering gull are the only birds to be seen. Mosquitoes, the summer plague of Northern Europe, do not occur.

There has never been any native population, but the land is not uninhabitable, as is proved by the fact that this winter over 500 miners are living there in comfort. Longyear City, the largest settlement, has some thirty large houses, comfortably furnished, many with central heating, and all lit by electricity. There are club-rooms, billiard tables, libraries, and even a kinema theatre, for the miners and engineers. Wireless telegraphy keeps them in touch with the outside world. There is a Norwegian post-office, and a well-stocked shop supplies all reasonable wants. Fresh meat brought from Norway in autumn is served out two or three times a week. There is practically no illness, now that scurvy is mastered, but the settlement has a doctor in residence and a small, well-equipped hospital. Several women have wintered and children have been born in Spitsbergen. A school and a church are to be built. Several centuries ago Spitsbergen had an even larger town occupied only during summer. That was Smeerenburg, the Dutch whaling settlement, which had a population of over 1,000, and contained shops, bars, and other amenities of civilization. With the decline of whaling the town was abandoned, and scarcely a trace remains to-day.

The geological structure of Spitsbergen, broadly speaking, shows two contrasted districts. Along the west coast and in the north of the archipelago there is a zone of old rocks ridged into mountain folds, and subsequently weathered into the sharp peaks which gave the country its name, while in the central and eastern parts there is a broad zone of newer rocks lying in the main in horizontal or gently inclined strata, and weathered into table-topped mountains. In the old rocks there are various metallic ores, including the iron-ore of Prince Charles Foreland, but it is in the newer rocks that the great coal deposits occur. Coal of three geological ages is found, Carboniferous, Jurassic, and Tertiary. Of these the Jurassic coal was first mined, but it proved to be of poor quality, and is no longer worked. The Tertiary coal, unlike the coal of that age in most countries, is of high calorific value and good for steam purposes. It is the principal coal mined at present. There appear to be several seams ranging in thickness from 3½ to 7 feet. Only one of them shows the least tendency to pass to lignite. The Carboniferous coal is a later discovery than the others, because its outcrops are frequently obscured by screes and slip masses, but the deposits are very extensive. It is the only coking coal in Spitsbergen. There are many seams totalling over 6 feet. There is little doubt that the total content of coal in Spitsbergen is over 5,000,000,000 tons.

Conditions are favourable for coal-mining. The extensive faulting of the almost horizontal strata has caused deep waterways into the heart of the country. Icefjord and its branches, and Lowe Sound lead to most of the coal seams. The coal can be reached easily by almost level adits into the hillside within a few hundred yards of good anchorage. The low temperatures prevent flooding and obviate the necessity for extensive pumping. Gas is practically unknown. Frost also helps to maintain a firm roof, and so reduces the

Continued on p. 26

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number of pit-props required. Mining continues throughout the year, the winter coal being stocked for export during the summer months.

Of course vessels have to go in ballast to Spitsbergen to load coal, as there are no northward cargoes except mining and building material, and food, but the distance from Norwegian ports is short, so that this is not a serious drawback. In fact, the chief difficulty in mining in Spitsbergen is not a material one, but lies in the prejudice against a land in the Arctic which the prevalent Mercator maps show apparently at a great distance from Europe.

It is too early, perhaps, to write of the other possible use of Spitsbergen, namely as a health resort, but it fulfils all the conditions required by people suffering from lung troubles. Some day this will be realized, to the benefit of many sufferers.

The sovereignty of Spitsbergen, after being discussed on many occasions since 1871, was given to Norway last year by the Paris Conference. On the whole the decision was an equitable settlement of a difficult problem. Norway's sovereignty is not absolute over the whole country, for pre-existing estates belonging to non-Norwegians are practically exempt, each being under its own administration, and Norway has no power to interfere with the development of those estates.

BOOKS

Spitsbergen: its Exploration, Hunting, and Mineral Riches, by R. N. Rudmose Brown, D.Sc. (London: Seeley Service, 1919.) (Includes early and modern history.)

No-man's Land, by Sir Martin Conway. (Cambridge University Press, 1906.) (Early history of Spitsbergen.)

First Crossing of Spitsbergen, by Sir Martin Conway. (London: Dent & Co., 1897.)

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The object of the expedition was to cross the Antarctic Continent on foot from Weddell Sea to Ross Sea, finding out as much about everything as possible *en route*. To this end the main party, under the leader, started off from the Weddell Sea side, and a second party commenced from Ross Sea. What the results would have been, had the plan of campaign succeeded, we do not know, though we can guess, but unfortunately, from the point of view of getting scientific information of Antarctica, the plan did not succeed. Shackleton's ship, the *Endurance*, got smashed in the ice of Weddell Sea, and he and his men had to leave it and take to the ice. After terrible experiences and great privations they reached Elephant Island. From this place Sir Ernest and a few of the party set out in a small boat over the sea to South Georgia, a nightmare of a journey, and then on foot over the hills and glaciers to Stromness, a whaling station. The rest of the party remaining on Elephant Island were rescued by Shackleton after three unsuccessful attempts to do so, and afterwards he went to the help of the other party which had commenced work from Ross Sea. There was, unfortunately, some loss of life, but most of the men and their leader returned safely to Europe and the war.

This is a book to enjoy before a fire. It has all the things we like to read about or see in books of Polar exploration—the penguins, the pack-ice, the sleigh-dogs, and the photographs. Owing to the failure of the enterprise, no great scientific work was able to be done. Many important problems, however, are raised, if not solved, by the voyage, and some important meteorological results are given in the text and in the appendix. But why should we worry over the lacunæ in our knowledge of those Southern parts, when such a failure has given us this record of adventure?

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By actual experience we have found the second of these methods the less depressing, the less likely to make us feel that intellectually we have gone very far downhill, and for those who think with us we recommend a re-study of Shakespeare and his times, beginning with a book like this one by Mr. Sykes, or with Mr. Robertson's excellent essay.

The object of the former book is to show that certain plays traditionally attributed to Shakespeare, and which in the general opinion of scholars may not be wholly his work, may be ascribed to definite men who were writing in Shakespeare's time. Mr. Sykes attempts to show that *Henry VIII*, notwithstanding its place in the first folio, is not Shakespeare's work at all. *The Two Noble Kinsmen* he attributes to Massinger; *Arden of Feversham* to Kyd; *King John* and *King Lear* to Peele; *A Yorkshire Tragedy* and the first two acts of *Pericles* to Wilkins.

Mr. Sykes arrives at these conclusions not from a discovery of new documents, or from any objective piece of evidence, but from the internal evidence of the plays themselves. By comparison of the supposed work of Shakespeare with the works of his contemporaries, he presents a number of remarkable parallels of phrases, words, rhymes, and tricks of writing, and, from these resemblances patiently tracked out, he draws his conclusions.

One must be on one's guard against this sort of thing. It may be all right, but then, again, it may not. But it is unfair to an author to conclude, because in the past a few *poseurs* and quacks have tried their hands at this type of research, that all who do it are such.

Mr. Sykes has tackled his problem with considerable insight and mature judgment, and has spared no pains in trying to get the truth. That is a great deal, and this book deserves the attentive study of scholars and students.

He is most successful in making out his claims for Peele and for Wilkins. This is Mr. Sykes' first book, we understand, and we look forward to a continuation of his activity in this field of work.

Mr. Robertson's contribution to the problem of Hamlet is an extraordinarily able and stimulating one. The chief theories that have been put forward in the past to explain the difficulties in the character of Shakespeare's most famous creation are described and reviewed. Mr. Robertson shows that many of these are to be ascribed to inconsistencies, attributable to the fact that Shakespeare was not creating a perfectly new play, but was building it up from old sources, especially from the old lost play of the same name by Kyd. Such is the main point, and in working it out the author has written a most interesting and helpful book.

The Last Four Months. By SIR FREDERICK MAURICE. (Cassell, *7s. 6d.* net.)

This is an interesting description of the events in France in 1917 and 1918 which led to the necessity of real co-ordination of action between the Allied armies on the Western Front, and to the choice of Foch as Commander-in-Chief. It deals particularly with that magnificent campaign of his which turned the colossal disaster of March into the victory which ended the war on the Western Front.

In writing this book Sir Frederick has not had the inside information that he had in his previous one, but nevertheless he has given a very lucid and graphic compilation from published sources of information. His defence of the retirement of Gough's Fifth Army in March, his opinions of the methods and strategy of the enemy, and his reasons for approving of the date of the Armistice, should be read with particular interest.

The Ghost World. By J. W. WICKWAR. (Jarrolds, *2s. 6d.* net.)

An interesting little book on this always popular subject. The author's advice, evidently, is to keep a ghost for our entertainment, as we keep a faery for our children. Although the ghostly phenomena are explained away, and our shudder develops into a laugh, yet the explanations are not dogmatic, and leave a wisp of belief for the lovers of "real ghosts." The unbelief is not so strong as that expressed by Mr. Jasper in *Edwin Drood*, as he talked with the "tombatic" old Durdles in the eerie precincts of the cathedral grave-yard:

> "But do you think there may be Ghosts of other things, though not of men and women?" says Durdles.
>
> "What things?" says Jasper. "Flower-beds and watering-pots? horses and harness?"
>
> "No. Sounds."
>
> "What sounds?"
>
> "Cries."
>
> "What cries do you mean? 'Chairs to mend'?"
>
> "No. I mean screeches. . . ."

Mr. Wickwar evidently "means screeches."

Italy from Dante to Tasso. By H. B. COTTERILL. (Harrap, 15*s.* net.)

This book is the work of a mature and widely-read scholar who, while making a distinctive contribution to Italian History of the period 1300—1600, has yet written it in a clear and interesting way that should be very acceptable to the general reader. The scheme of this volume is similar to the author's previous work on *Mediæval Italy*—that is to say, the period under considera-

[*Continued on p. 28*

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The importance of a knowledge of physical chemistry in technical processes is now widely recognized, and, as a consequence, the subject is receiving more and more attention both in the class-room and the laboratory, and at the works. To fit workers to acquire and appreciate the many important points involved, a good general introduction to the whole subject is necessary, and this Prof. Walker has written with the maximum appeal to experimental work, and the minimum to higher mathematics.

The new chapters deal with recent discoveries in radio-activity, in crystal structure, and in the nature of the atom, and these chapters should interest the general reader most. Of one of these new pieces of work we shall now give a short account.

Until quite recently there was no special reason to believe that the number of elements known to the chemist was a fixed and definite one. About eighty or so different elements were known, but from time to time research workers announced a new element, and in some cases this discovery was confirmed by others. For all we knew, then, there might really be a hundred or a hundred and fifty elements, and the reason why we had not found them all was simply that we were not clever enough. But this somewhat pessimistic view is no longer tenable. Hydrogen is the lightest of elements, and uranium (a rare element) the heaviest, and between these two substances there are ninety others only.

The chief credit for this discovery belongs to Moseley, a young Oxonian who worked in Manchester, and who was killed in the war. Moseley showed, from a study of the X-rays produced by different elements, that each element has a number which belongs to it, and to it alone. Thus the number that belongs to mercury is 80, to gold 79, to platinum 78, and so on. Now, while every different element has its own particular number, there are some numbers for which there is no known element. There is, for example, no element which, when examined by Moseley's method, corresponds to the number 43. Here, then, is an element which is still unknown, and, if Moseley's work is right, the only elements which are still to be discovered are those for which we have the number but no corresponding substance. If hydrogen's number is taken as 1, uranium's number is 92, so that there are altogether 92 elements. Of course, there may be elements heavier than uranium, or lighter than hydrogen; and, if so, this number 92 would be increased accordingly, but until such are discovered, we may conclude there are 92 only.

Of these the chemist has discovered 86, so that six alone remain to be found. This is extremely creditable to the chemist. Not only has he discovered nearly 94 per cent. of the total number of possible elements, but of the number of bodies which chemists have agreed to look upon as elements, not one was proved, by Moseley's wonderful and illuminating method, to be spurious.

Catalysis in Theory and Practice. By E. K. RIDEAL and H. S. TAYLOR. (Macmillan & Co., 17*s.* net.)

Catalysts are substances which change the velocity of a chemical reaction without apparently themselves taking part in it. Thus if a quantity of alcohol be added to a quantity of acetic acid, a chemical reaction will take place at a definite rate, and will continue till only a small part of the original quantity of alcohol is left. By repeating the experiment and adding to the mixture this time a small quantity of sulphuric acid, the reaction takes place at an enormously increased speed. This small amount of acid has nothing to do with the cause of the reaction, and no influence on the extent to which it goes. Its action is simply to "speed-up" things. Such accelerators, it will be realized, are of great importance in industry, in the manufacture of substances, for example, like indigo, ammonia, and alcohol, for there is no kind of chemical reaction which cannot be influenced by these catalytic substances.

The authors of this work have made a valuable compilation of the chief phenomena associated with catalysis, studied both from the practical and the theoretical side. It should be a serviceable textbook for all "finished" chemists.

The World's Minerals. By L. J. SPENCER. (Chambers, 10*s.* 6*d.* net.)

An excellent book for the general reader by one who is well qualified to write on his subject. It gives an interesting and very readable account of the more important minerals. The title rather suggests that the book deals with minerals from a commercial or economic view, but this is not so. The place that minerals occupy in commerce as ores of metals, as gems, and so on, is of course mentioned, but the book deals chiefly with the appearance, structure, and characteristics of the minerals themselves. More than a hundred are described. The diagrams are clear, and the coloured plates, illustrating the minerals, are really excellent.

The Amœbæ Living in Man. By CLIFFORD DOBELL. (John Bale, Sons & Danielsson, 7*s.* 6*d.* net.)

This book is written by one whose chief interest in the subject is from the zoological standpoint, and its appeal is both to research workers in protozoology, and to doctors who are making a special study of the diseases produced by protozoa, especially dysentery. Knowledge concerning the amœbæ living in man has hitherto been in a state of some confusion. Mr. Dobell has set himself the task of collecting the true facts of the subject, and from an exhaustive study of the literature, a large personal experience of research, and from the exceptional opportunities that the war has afforded him of studying a very large number of cases, he has been able to advance our knowledge of these amœbæ to a state approaching finality. He has put his readers on their guard against many erroneous facts and conclusions which appear in the literature and the textbooks. Medicine and Zoology alike are indebted to the author for this accurate, exhaustive, and illuminating work. It is hoped that the results and conclusions given in this book by Mr. Dobell, and his classification of the genera of amœbæ, will find a place soon in the newer textbooks. A valuable bibliography is appended.

The Army and Religion. An Inquiry, and its Bearing upon the Religious Life of the Nation. (Macmillan & Co., 6*s.* net.)

During the war, a committee, of which the joint-conveners were the Bishop of Winchester and Professor Cairns of Aberdeen, was formed to make an investigation, as complete as possible, of the attitude of serving soldiers towards religion and the Church. A questionnaire was prepared and widely circulated among all ranks; the replies to the questions were carefully analysed, and from the analysis such facts as were plain, and such conclusions as could be honestly drawn, were set down. The result is this book, a work of great importance and of vital interest to everyone interested in the men who fought in the war, and to those anxious for the welfare of the country in these first years of peace.

Some of the questions set or suggested to those who replied are these: What do the men think about Religion, Morality, and Society? Now that conventions are set aside, what faith and standards are the men living by? What are the chief difficulties in the way of belief independently of those raised by the war? What do they criticize in the present social order? Has the war made any real difference in their moral and religious outlook and character? Has it made them think more deeply? Are the men interested in how to bring about a better world and an enduring peace? Do intellectual hindrances count for much in producing indifference to the Churches?

The first part of the book deals with the numerous answers received to these and other questions; in the second part the answers are ably and sympathetically discussed.

The book gives a reader lots to think about. There is a candour and spontaneity about it that is very attractive. No attempt is made by the compilers to ram any ready-made theories down one's throat. They have given the facts of the matter as they have come to their knowledge. It is for the reader to consider these, to agree with or criticize them, and to act.

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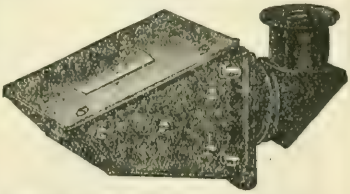

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Crystal Structure

By W. L. Bragg, M.C., M.A.

Nobel Laureate: Langworthy Professor of Physics in the University of Manchester

When a liquid solidifies on cooling, or when a solid is deposited from a solution, the attractions between the molecules cause them to pack themselves together into a rigid structure. This can happen in two ways: the molecules may come together in any position, or they may arrange themselves in a regular pattern. In the first case the solid is said to be amorphous; in the second case it is called crystalline. The amorphous and crystalline states may be compared to a number of men forming a crowd, and to the same number drawn up in military formation.

In the great majority of cases, the molecules, when forming a solid, arrange themselves in a regular crystalline structure, and it is only under exceptional circumstances that amorphous solids are produced. The mineral constituents of the earth's crust are almost entirely crystalline: metals are composed of a mass of small crystals, solutions deposit the dissolved body as crystals. Ice consists of a mass of water crystals, frost of the same crystals deposited by the condensation of vapour. When the molecules are given time, as it were, to arrange themselves regularly, there is always a tendency to form a crystalline structure. Glass, on the other hand, is a typical example of a class of solids called "vitreous" which show no evidence of crystalline structure.

When a crystal is not disturbed in its growth, its crystalline nature is shown by its having a number of plane surfaces meeting in straight edges, which are often symmetrically disposed. Although the extent to which these surfaces are developed may differ greatly from crystal to crystal, the angles between corresponding faces are always the same for any given substance. This can only be due to there being for every substance a regular pattern in which the molecules are always arranged when it crystallises.

This is illustrated by the two-dimensional model of Fig. 1, where the circles represent the molecules of a crystalline structure.

The figure shows how the two-dimensional "crystal" will have straight edges, formed by adding rows of molecules as the crystal develops, and if we imagine the same process to take place in three dimensions, the way in which the plane faces of a crystal grow, by the adding of layer after layer of molecules, can be pictured. It is not the possession of plane faces which

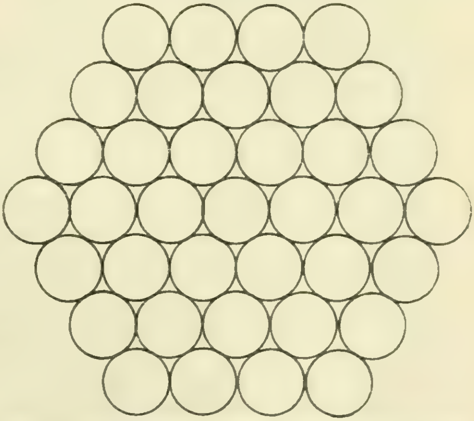
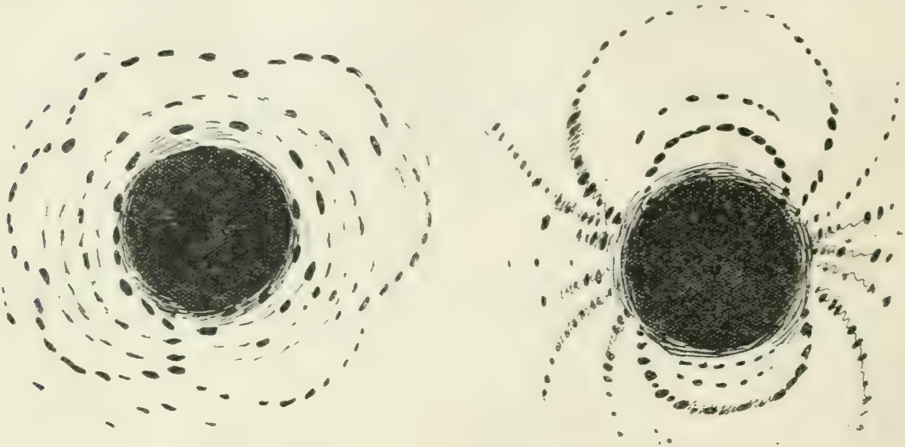


FIG. 1.—TWO-DIMENSIONAL MODEL OF CRYSTAL STRUCTURE.

constitutes the crystal, they are merely the evidence of the internal regular arrangement.

The exact way in which the molecules of a crystal are arranged has always been a matter of great interest, but the extreme minuteness of the pattern has until recently been an insuperable obstacle to investigation. When examining small objects with a microscope the power of resolution is limited, not by the impossibility of designing a better instrument, but by the size of the light waves which we use to illuminate the object. It is impossible to see any detail of a body smaller than the wave-length of light, because the wave-trains coming from the different parts of the body cannot be distinguished from each other. The finest detail we can hope to examine with a microscope corresponds to the shortest wave-length of light we can use. Taking as unit of length the Angstrom unit, which is one hundred-millionth of a centimetre, we cannot see detail finer than about 3,000 Angstrom units. The distances separating the molecules in a crystal we know to be of the order of two or three Angstrom units, and so they are far beyond the possibility of microscopic investigation.



BERYL. NICKEL SULPHATE.

FIG. 2.

The discovery which opened the way towards finding how a crystal was built was made in 1912 by Laue. He was inspired to try the effect of passing a beam of X-rays through a crystal. It had already been suspected that X-rays consisted of electromagnetic waves of exactly the same nature as heat and light radiations, but with a wave-length which was one ten-thousandth that of visible light. Laue realised that such waves are smaller than the distances between the atoms in a crystal, and that they provide a source of illumination which is capable of revealing its detailed structure. In carrying out his experiment, Laue expected to get an effect on the X-rays analogous to that of a diffraction-grating on light. The diffraction-grating consists of a plate of polished metal on which a very large number of fine lines have been ruled by a diamond point at regular intervals, spaced so that there are from ten to twenty thousand lines to the inch. When light falls on such a grating, each line scatters or "diffracts" a small portion of the incident light. If light of definite wave-length is examined, there are certain directions in which the wave-trains scattered by the lines of the grating are exactly in phase with each other, the crests and troughs of the waves coinciding in position, so that they combine to form a strong diffracted beam. In other directions the waves are not in phase, and the general effect is zero. The analysis of a spectrum by a grating depends on this principle. Laue realised that a crystal provides a diffraction grating where the regular arrangement of molecules takes the place of the lines ruled on a metal grating, and where the distance between the molecules is of the right dimensions to diffract the very short X-rays.

The results which he obtained when he passed a beam of X-rays through a crystal are shown in Fig. 2. In his apparatus a very narrow pencil of rays fell on a small slip of crystal, and a photographic plate was placed on the far side at right-angles to the rays. The large spot in the centre of the plate is produced by the direct beam of rays, the pattern of small spots surrounding it by the diffracted beams. The symmetry of the patterns of spots is that of the crystal used, and this shows that it is the molecular pattern of the crystal which is causing the diffraction.

This discovery has led to investigations which have greatly enlarged our knowledge both of X-rays and of crystal structure. We now know how the atoms are arranged in a large number of the simpler crystal structures; we can make a model showing their positions in the pattern, and these models explain those features of crystal symmetry which have, so far, been studied by means of the crystal's external appearance only. Using the crystal as a diffraction grating, we can, on the other hand, measure the wave-length of the X-rays, just as the wave-length of visible light can be measured with a diffraction grating.

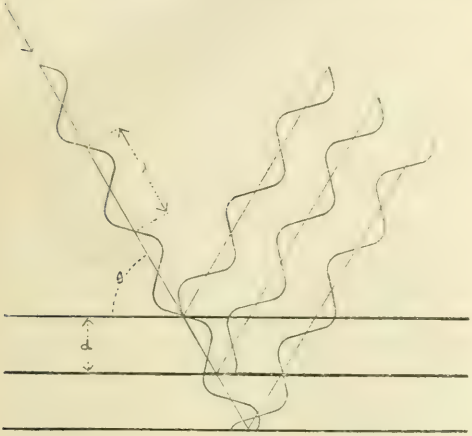


FIG. 3.—REFLECTION OF A WAVE-TRAIN FROM THE PLANES OF A CRYSTAL STRUCTURE. CONDITION FOR REINFORCEMENT $\lambda = 2d \sin \theta$

Let us suppose that a beam of X-rays is allowed to fall on the face of a crystal. We have seen how the face may be considered as being built up, as the crystal grows, by layers upon layers of molecules arranged in planes one on top of the other. Consideration shows that each of these layers is capable of reflecting a very small proportion of the train of waves constituting the X-rays, so that a number of reflected wave-trains are produced as shown in Fig. 3.

If A, B, C, D represent the planes of a crystal structure, then waves coming in the direction of the arrow will be partly reflected at each plane. The waves reflected from the plane B have gone a greater distance than those reflected at A, those reflected at C a still greater distance, and we have here the same conditions for the interference of the waves as we have in the case of a grating and light waves. If the extra distance which is traversed by the waves reflected from B, as compared with those reflected from A, is exactly one wave-length, the two sets of waves will reinforce each other. So also will those reflected from C, D, and the other planes, and the combined reflected beam will be strong. If, however, the crystal is set at such an angle that the waves do not reinforce each other, they will interfere and reflection will not take place. The condition that reflection should take place depends on the distance between the crystal planes and on the angle at which the X-rays fall on it. Measurement of the angle when X-rays of a known wave-length are used tells at once the distance between the layers of molecules parallel to a face.

If we measure this distance for various faces of the crystal, we can find out the way in which the molecules are arranged. For instance, referring again to the two-dimensional model shown in Fig. 1, if the distances between the rows of molecules which are parallel to various faces are found, it will be clear that the arrangement of the molecules in that figure can be deduced. The measurements tell us the framework,

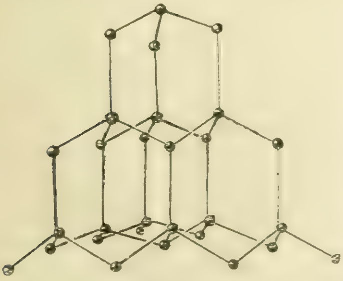


FIG. 4a.—ARRANGEMENT OF CARBON ATOMS IN A DIAMOND.

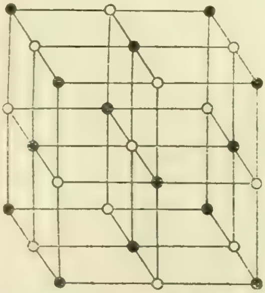


FIG. 4b.—ARRANGEMENT OF ATOMS IN A ROCK SALT (NaCl) CRYSTAL. WHITE CIRCLES REPRESENT SODIUM ATOMS, BLACK CHLORINE.

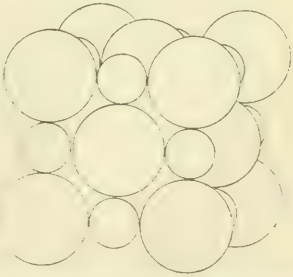


FIG. 4c.—MODEL OF ROCK-SALT STRUCTURE THE LARGE CIRCLES REPRESENT SODIUM ATOMS, THE SMALL CHLORINE ATOMS.

as it were, of the structure on which the molecules are packed.

This is only the first step towards finding out the crystal structure. Each molecule is composed of a number of atoms. The positions of the atoms are found by comparing the strength of the reflected beam from any face when the path difference causing interference is one wave-length, two wave-lengths, three wave-lengths, and so on. Anyone familiar with the diffraction-grating will know that it gives, for a definite wave-length, several spectra, which are distinguished as being of the first, second or third order. The relative strengths of these spectra depend on the form of the scratch ruled on the grating by the diamond point when it is being prepared. In the case of a crystal, that which corresponds to the scratch is the molecule itself, and a study of the different orders of reflection tells us the arrangement of the atoms in the molecule. Some crystal structures worked out in this way are shown in Fig. 4.

Knowledge of these structures opens up many possibilities. Now that we know how the atoms pack themselves when they bind together, we may be able to find out the nature of the forces which cause them to do so. These forces must be of the same nature as those causing elements to combine to form chemical compounds. It is interesting to note that, in a structure such as that of rock salt, there is no evidence of the existence of the molecule in the ordinary accepted form. The sodium atom touches six neighbouring chlorine atoms, to any of which it may be considered as belonging. The same thing is found in all the crystals investigated. The diamond structure is interesting because each carbon atom touches four other atoms around it, agreeing with many other properties of carbon which suggest that carbon has four "bonds" arranged tetrahedron-wise, linking it up to the atoms combined with it.

We can carry our investigations a stage further. In the case of an element, when all the atoms are alike, that which corresponds to the "scratch" on the grating is the atom, and by examination of the different orders of reflection it may be possible to find out the arrangement of the different parts of the atom. The wave-length of X-rays is so small that we may use them to look into the interior of the atom itself.

Again, knowledge of the crystal structure tells us the distances between the atoms in a crystal, and if we think of the atoms as small hard spheres packed tightly together, we can get an estimate of the size of these spheres. In Fig. 4*c* an attempt has been made to represent the sodium and chlorine atoms with their relative sizes as found in this way.

These examples will perhaps give some idea of the vast interest now attached to the study of crystal structure. The diffraction of X-rays by crystals has not only led to a far more complete knowledge of the properties of X-rays, but it also affords one of the most promising lines of attack on the problem of atomic structure.

X-rays and Crystal Structure, by Professor W. H. Bragg, M.A., F.R.S., and Professor W. L. Bragg, M.A. Fifth edition. (London: G. Bell & Sons. 10*s*. 6*d*. net.)

Ions, Electrons, and Ionising Radiations, by J. A. Crowther, Sc.D. (Arnold, 12*s*. 6*d*. net.)

A System of Physical Chemistry, vol. i, by Professor W. C. McC. Lewis, D.Sc. (Longmans, 15*s*. net.)

The Wars of Greek History

By W. R. Halliday, B.A., B.Litt.

Professor of Ancient History in the University of Liverpool

"In one point of view," says Aristotle, "the art of war is a natural art of acquisition, for it includes hunting, an art which we ought to practise against wild beasts, and against men who, though intended by nature to be governed, will not submit."[1] He does not, however, believe in the militarist State. "Men should not study war with a view to the enslavement of those who do not deserve to be enslaved; but first of all they should provide against their own enslavement; and in the second place obtain empire for the good of the governed, and not for the sake of exercising a general despotism; and in the third place they should seek to be masters only over those who deserve to be slaves. Facts, as well as arguments, prove that the legislator should direct all his military and other measures to the provision of leisure and the establishment of peace. For the most of these military States are safe only while they are at war, but fall when they have acquired their empire; like unused iron they lose their edge in peace time."[2] Aristotle is always sensible and often profound.

Successful wars from the seventh century B.C. to A.D. 1870 have in fact provided foundations for national development. At certain stages of a nation's growth, strong government at home, combined with successful aggression abroad, promotes national solidarity and stimulates national consciousness. There is more than one analogy to be drawn between the work of the Greek tyrants[3] and that of our British Tudors. Further, the spoils of an energetic foreign policy may finance the material progress of the community. The great buildings of Syracuse, for example, or those whose ruins line the cliffs at Girgenti in Sicily, were paid for by indemnities exacted from the Carthaginian, and built by the cheap slave labour with which the over-

[1] *Politics*, I, 8, 12.

[2] *Politics*, VII, 14, 22.

[3] In the sixth century B.C.

whelming victory of the Greek at Himera[1] had glutted the market. Similarly, a result of the great wars with Carthage and the Eastern Powers was to concentrate the capital of the world in Roman hands, and provide in large quantities the cheap labour of slaves. The art of war may be an "art of acquisition." Clearly, however, such wars must be limited in area and in duration. The German instinct for a short war is sound enough. The victor must not be too exhausted to profit, nor the vanquished to pay.

The great war in which a handful of Greek states faced and defeated the armies of Persia[2] was fought "to provide against their enslavement." The victory vindicated that conception of the nature of the state which the Greeks discovered, and which forms to-day the basis of Western political thought. It was a victory for the idea that the community exists in order to provide the good life for its citizens, who are free but responsible members actively participating in the life of a living whole, as against the Oriental conception of irresponsible personal government under which the state exists primarily for the benefit of the governor rather than for that of the governed.

But while it justified the conception of the state which had been developed in the small Greek communities, the Persian War put an end to the scale upon which it had been worked out. Hellenism was called upon to play an international political rôle, and the new conditions demanded the creation of a larger political unit than the city-state. Inevitably the league of maritime cities formed to complete the war with Persia became the Athenian Empire. The league ceased to be a voluntary federation from which members were at liberty to withdraw, and became an aggregate of subject states dominated politically and commercially by the mistress of the seas. And while Athens claimed, with some justice on the material side, that her empire was "for the good of the governed," her subjects had reason to regard it as "the exercise of a general despotism." For the political imagination of the Athenian did not perceive that the principle which held good for the city-state must be extended to the larger unit; that for empires to endure, subjects must become free and responsible citizens, and the whole a living organism in whose life the parts have an effective share. That, however, is a lesson hardly learned. The Romans learned it only by bitter experience, and it needed the political vision of Julius Cæsar in 49 B.C. and Augustus after 31 B.C. to extend the moral of the Social War[3] in which the Italians had extorted by armed revolt the franchise which they had failed to obtain by constitutional means. It needed, too, the rebellion of the American colonies to enlighten British imperial policy.

[1] 480 B.C. [2] 490–479 B.C. [3] 90–89 B.C.

The true background, however, to the ideals so eloquently stated in the Funeral Speech of Pericles[1] is the tyrant empire, which in its very being contradicted the fundamental quality of the Greek political ideal. And this it was which made the Peloponnesian War inevitable. The revolt of Samos against the Empire had been suppressed, but there could be no enduring peace.

Thucydides, the great Athenian historian, shows that the moral force of Greek public opinion was on the side of the adversaries of Athens, who were able to make their battle-cry the liberation of fellow-Greeks from an imperial yoke.[2]

In fact it would seem that his literary sympathies have led Professor Murray astray, when he tells us "that, alas! there was no America to make sure that the right side won."[3] For the Peloponnesian was like the European War, inasmuch as the last round was decided by the intervention of a neutral. (It was Persian gold and Persian shipbuilding timber which decisively loaded the scales against Athens at the end.) But it was unlike the European War inasmuch as there was no "right side." The liberators proved, in fact, to have no positive programme. The necessity for a larger political unit than the city-state remained, and empire was forced by circumstance upon them. In proportion as they were stupider, the ever ruder successors of Athens made each a more conspicuous failure than the last. Nor was Dionysios in Sicily in the fourth century B.C. more successful than Sparta and Thebes in Greece.

In fact the Greeks discovered the true principle of the state, but failed to embody it in a political unit of adequate scale. Greek history after the Persian Wars is a catalogue of their failures in practice, while Aristotle betrays the degree of their failure in theory, when he preserves the ideal of political society only by mapping the world into a series of self-centred, isolated city-communities.

There are many points of similarity between the Peloponnesian and the European Wars. How similar were the conditions of life in Athens and in London may be read in the lecture of Professor Murray to which I have referred. The Athenian, like ourselves, knew what it was to be short of food, fuel, and light. Pestilence, like influenza, claimed even more victims than the battle-fields. Beside our modern mediums may be placed the oracle-mongers, whom Aristophanes so cordially disliked, and as regards secular credulity the legend of the landing in England of a large contingent in 1914 is paralleled by the fantastic hopes entertained

[1] In 431 B.C., the first year of the war of the Peloponnesians against Athens.

[2] Thucydides, II, 8.

[3] Creighton Lecture, 1918, *Aristophanes and the War Party* (Allen & Unwin, 1s. net), p. 9.

by Athenians of their Thracian allies. Labour, both domestic and skilled, with them as with us, though for different reasons, became difficult to handle. These and other similarities lead up to the main theme of the lecture, an exceedingly interesting study of the effect of a world-war then and now upon the psychology of politics.

Of the soundness of the parallel in essentials the reader of the lecture will be able to judge. There is in passing a small but curious coincidence which Professor Murray has omitted. Even ruthless sea warfare is a novelty only in its instrument. In this struggle between a maritime empire and a military state, the weaker naval power declared ruthless war upon all sea-borne commerce. Precisely in the same way twenty-three centuries earlier "the Lacedæmonians killed as enemies all whom they took at sea; whether confederates of the Athenians or neutral."[1] The policy was ineffectual, for Sparta was weak above water and lacked the furtive weapon of the submarine. And in ancient as in modern times it had diplomatic disadvantages. We read of representations made to a Spartan admiral that it is a bad way of setting the Greeks at liberty to kill men who have not been guilty of hostile action, and who are not enemies to the Peloponnesians, but confederates to the Athenians by constraint; and that, unless he gave up that course, he would make few of his enemies friends, but turn many now friends into enemies.[2]

The Peloponnesian War differed from the wars of national expansion, or the wars of independence against a foreign invader, in being a war of long duration in which all parties fought to the pitch of exhaustion. In the course of the struggle every Greek state of importance became involved, and from the Greek point of view it was a world-war. Its conclusion left Athens humbled, and her empire shorn away, Sparta, with her domestic institutions strained to the point of revolution, faced with a task abroad with which she was wholly unable to cope, and the rest of the Greek world, like Europe to-day, worn out.

Professor Murray's lecture suggests the possibility of a sequel. While history does not repeat herself with the exactitude in which Thucydides believed, her similarities are not uninstructive. In Athens, as in this country, war-expenditure, depleted resources, inflated currency, and high prices lent a grave importance to financial questions.

The art of the statesman in the fourth century becomes largely the art of making ends meet. Then, as now, there were those who believed that nationalisation provided a panacea for national financial difficulties, and Xenophon's treatise upon *Ways and Means* is largely a plea for the working by the state of the silver-mines, which, though the property of the state, were leased for a premium and rent to the private prospector or industrialist. The financial reserves of Athens, which Pericles had stored in the Parthenon, had in the course of the war been coined and put into circulation. Inflated currency had assisted the scarcity of necessaries in raising prices. The purchasing power of money in the age of Demosthenes was five times less than in the age of Solon.[1] Increase in the cost of living had led to an increase in the amount of state payment for public service, a vicious circle with which we are familiar enough.

Individuals of the middle class were in many cases in financial straits. The landowner and the agricultural middle class had been ruined by the Spartan invasions of Attica. Devastated farms glutted the market, and prudent capitalists like Ischomachus and his father found land a cheap investment. Large estates worked industrially by slave-labour thus supplanted the yeoman's holding. Individuals, again, who had held property in the empire came back to Athens, having lost their possessions. We hear of persons, previously affluent, who are taught by misfortune that working for a living is no disgrace, and Socrates solves the difficulties of a friend, who has a large number of female relations dependent upon him, by suggesting that they should be set spinning and weaving for the market. Capitalism increases, but wealth had passed to a new class. Munition makers almost alone had come out of the war with profit. The fourth century sees the rise of bankers, an ex-slave like Pasion, and the typically spendthrift son of the parvenu like Apollodorus.[2]

Athens maintained her relative importance in the Greek world partly because she became, in a sense other than that intended by Pericles, "the school of Hellas," but mainly because of the sea-borne traffic which inevitably flowed to her great harbour the Peiræus as the central port of Greece. If her condition was bad, that of the rest of the Greek world was worse. Disorder ruled upon land and sea. The land was full of broken men, bandits and desperadoes, while the fall of Athenian power had filled the sea with pirates. Peace was impossible, and the recurring combinations against the paramount power of the day led to a series of fruitless wars enfeebling still further the already exhausted Greek states. The power which Persia showed in 387 B.C. to dictate the settlement of Greek domestic quarrels corresponds to the real facts of the situation. The Greek world had bled itself to exhaustion.

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[1] Thucydides, II, 67, 4.

[2] Thucydides, III, 32.

[1] Boeckh, *Public Economy of Athens* (translated by Lewis), p. 6. Prices were of course rising throughout the period. The spoils of the Persian War enormously increased the amount of coin in circulation. But the rate of inflation increased with war-expenditure, and prices went up with a bound. The depreciation of the value of money continued through the fourth century, in the course of which the Phokians put the treasures of Delphi into circulation. The value of money, particularly of gold, reached its lowest when the conquests of Alexander flooded the money market with the immense reserves of the Persian Empire.

[2] The general reader will find further information in a most attractive form in Glover's *From Pericles to Philip* (Methuen, 1917).

There were not wanting minds which felt that the necessity for Hellenism was union in the place of discord. Professor Murray has pointed out how a revulsion from the experienced horrors of a world war had created dreams of an ideal city where even men have wings.[1] And a more practicable ideal belongs to the same movement of thought. Even during the war, from the publication of the *Peace*[2] onwards, the idea that men should become "good Hellenes" is markedly in Aristophanes' mind. The disintegration resulting from the conclusion of the great conflict loosened local ties, and thereby not only contributed to the marked growth of individualism in the fourth century, but also strengthened the common bond of Hellenism. As a definite political programme, the prototype of the League of Nations finds its spokesman in the Athenian orator Isocrates, who is interesting precisely because he is not a great original thinker, but the mouthpiece of a considerable body of sensible opinion. The discord, jealousy, and rivalry of a narrower patriotism however prevailed. A free and voluntary League of Hellenes never came into being. It was left to the Macedonian Philip and his son, Alexander the Great, to enforce order in the Greek world before conquering Persia and the East. It is to be hoped that the League of Nations will be more exactly realised than were the original aspirations of Isocrates, and that the goodwill of sensible European opinion will find some really effective expression. If not, it would appear that the parallel between the Greek and European worlds in war-time may be extended to the subsequent periods. To students of the history of Greece in the fourth century this is no attractive prospect.

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[1] Murray, op. cit., pp. 10, 11.

[2] Aristophanes put his comedy, the *Peace*, upon the stage in 421 B.C.

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The Number of the Elements

By C. G. Darwin, M.C., M.A.

Fellow of Christ's College, Cambridge

THE main endeavour of pure science is to proceed from the study of particular cases to the general laws underlying them. In this respect it is not very surprising to find that chemistry is far behind physics, for chemistry studies the differences between different kinds of matter, whereas physics looks for the unifying principles which underlie them all. In fact, it is hardly too much to say that, as soon as any important generalisation is made in chemistry, the subject of it is promoted (or degraded—according to the reader's taste) to the rank of physics. Thus the beautiful theory developed by the application of thermodynamics to chemistry is dignified with the name Physical Chemistry. The present article deals with another invasion of physics into the chemical domain, an investigation of the fundamental qualities which serve to distinguish between the chemical elements.

In chemical theory a very important part is played by the "Periodic Law." It would take too long to discuss this law fully, nor is it needed for our purpose. Its main point is this: If all known elements are arranged in order of their atomic weights,[2] it is found that certain chemical properties recur at definite intervals. Thus lithium and sodium are both of the group called alkali elements, and are 8 apart, similarly oxygen and sulphur, another pair of closely related elements. For the lower atomic weights the cycle goes by eights, but after two complete cycles it changes and goes by eighteens. In three cases—argon and potassium, cobalt and nickel, tellurium and iodine—it is necessary to invert the order of atomic weights to fit in with the chemical characters. The resemblances of corresponding elements are sometimes not very marked, but they are enough so to prove that there must be some underlying principle, and to enable the chemist to predict the existence of elements through the presence of a gap in the table. Indeed, three of the rarer elements were foretold in this way before their discovery. There still remain two gaps in the table, where there appear to be places for elements that no one has ever found. They ought to be homologous—that is to say, generally similar—to manganese. In the table it will also be seen that there is a curious inter-

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[1] A good account of the development of the Periodic Law will be found in the *Encycl. Brit.* under the heading "Elements."

[2] The atomic weight is the weight of an atom of the substance measured on such a scale that the weight of hydrogen is 1. In practice, for technical reasons, it is more usual to take that of oxygen as 16, which is almost exactly the same thing.

THE PERIODIC TABLE

0	I	II	III	IV	V	VI	VII	VIII		
							Hydrogen 1 H 1·008			
Helium 2 He 3·99	Lithium 3 Li 6·94	Beryllium 4 Be 9·1	Boron 5 B 11·0	Carbon 6 C 12·00	Nitrogen 7 N 14·01	Oxygen 8 O 16·00	Fluorine 9 F 19·0			
Neon 10 Ne 20·2	Sodium 11 Na 23·00	Magnesium 12 Mg 24·32	Aluminium 13 Al 27·1	Silicon 14 Si 28·3	Phosphorus 15 P 31·0	Sulphur 16 S 32·07	Chlorine 17 Cl 35·46			
Argon 18 A 39·9	Potassium 19 K 39·1	Calcium 20 Ca 40·1	Scandium 21 Sc 44·1	Titanium 22 Ti 48·1	Vanadium 23 V 51·0	Chromium 24 Cr 52·0	Manganese 25 Mn 54·9	Iron 26 Fe 55·9	Cobalt 27 Co 59·0	Nickel 28 Ni 58·7
	Copper 29 Cu 63·6	Zinc 30 Zn 65·4	Gallium 31 Ga 69·9	Germanium 32 Ge 72·5	Arsenic 33 As 75·0	Selenium 34 Se 79·2	Bromine 35 Br 79·9			
Krypton 36 Kr 82·9	Rubidium 37 Rb 85·4	Strontium 38 Sr 87·6	Yttrium 39 Y 88·7	Zirconium 40 Zr 90·6	Niobium 41 Nb 93·5	Molybdenum 42 Mo 96·0	**43**	Ruthenium 44 Ru 101·7	Rhodium 45 Rh 102·9	Palladium 46 Pd 106·7
	Silver 47 Ag 107·9	Cadmium 48 Cd 112·4	Indium 49 In 114·8	Tin 50 Sn 118·7	Antimony 51 Sb 120·2	Tellurium 52 Te 127·5	Iodine 53 I 126·9			
Xenon 54 Xe 130·2	Caesium 55 Cs 132·8	Barium 56 Ba 137·4	Lanthanum 57 La 139·0	Cerium 58 Ce 140·2	Praseo-dymium 59 Pr 140·9	Neodymium 60 Nd 144·3	**61**			
	Samarium 62 Sa 150·4	Europium 63 Eu 152·0	Gadolinium 64 Gd 157·3	Terbium 65 Tb 159·2	Dysprosium 66 Ds 162·5	Holmium 67 Ho ?	Erbium 68 Er 167·7			
	Thulium 69 Tm 168·5	Ytterbium 70 Yb 173·5	Lutecium 71 Lu 175·0	Keltium 72 Kt ?	Tantalum 73 Ta 181·5	Tungsten 74 W 184·0	**75**	Osmium 76 Os 190·9	Iridium 77 Ir 193·1	Platinum 78 Pt 195·2
	Gold 79 Au 197·2	Mercury 80 Hg 200·6	Thallium 81 Tl 204·0	Lead 82 Pb 207·2	Bismuth 83 Bi 208·0	Polonium 84	**85**			
Ra Emanation 86	**87**	Radium 88 Ra 226·0	Actinium 89	Thorium 90 Th 232·4	Uranium X_2 91	Uranium 92 U 238·2				

For convenience in printing, the part of the table periodic in 18 has been brought into a reduced number of columns. The Roman figure at the head is the number of the group in which the elements vertically below it are classed. The table is read as follows :—Helium, atomic number 2, chemical symbol He, atomic weight 3·99. Where the element is unknown its number is printed large. Among the radio-active elements, only one of several "isotopic" substances has been put in the list. ("Isotopes" are defined later.) Most of the atomic weights of these substances have not been measured. The "rare earths" have no correspondence in properties with the other elements of the columns under which they happen to fall. The three cases where the order of atomic weight must be inverted are A and K, Co and Ni, Te and I.

lude, which is filled by the elements known as the "rare earths." More than a dozen of these are known to chemists, almost all very rare, and so alike that it is only with the greatest difficulty and patience that they can be separated from one another. After this interlude the periodic system returns and continues to the end of the list. Owing to the complete breach with the periodic law, the chemist cannot say whether there are any elements among the rare earths still to be discovered. The physical experiments which I am going to describe prove conclusively that between hydrogen and uranium there are 5 undiscovered elements—the two of the manganese group, one rare earth, and two more among the radio-active elements which come at the end of the list. These results follow from experiments which go much further into the fundamental nature of atoms than is ever done in chemistry. All trace of periodicity or chemical peculiarity disappears, and is replaced by a perfectly orderly progression of properties from which we can argue with absolute confidence.

In examining the atomic weights in the table, it will be observed that (especially near the beginning) the majority of them are almost exactly whole numbers. A great deal of speculation has been built up on this subject in the face of considerable difficulty, because a few, especially chlorine at 35·46, resolutely refuse to conform to the rule. Obviously, but for these exceptions, it would have been reasonable to suppose that all atoms were built up out of hydrogen atoms. Some work done only two months ago has entirely revolutionised this question, and in view of its interest and novelty, it will not be out of place to discuss it here, the more so as it has a considerable bearing on the theory of the fundamental nature of matter.

The electrical theory of matter was developed by J. J. Thomson and his school about twenty years ago. Thomson showed that all atoms contain a common substance—the electron, a particle with a perfectly definite and constant charge of negative electricity, and of mass about one eighteen-hundredth of a hydrogen atom. The question then arises, How many electrons are there in an atom? From their mass we can only say less than 1,800 (in the case of an atom of hydrogen), and to get a more definite value we must adopt some other line of attack. Now an atom is an exceedingly impenetrable body, and any ordinary experiment, say of a chemical or of an optical kind, really touches its surface only. In order to find out what is inside the atom, very much stronger measures must be taken, and these the discovery of X-rays and radio-activity placed in the hands of the physicist.

When a beam of X-rays traverses matter, a certain amount is scattered in much the same way that the air scatters sunlight and causes the sky to be blue. The amount scattered can be used to get an estimate of the number of scattering centres, the electrons, in much the same way that the brightness of the sky shows how the upper air is constituted. The first estimate of the number of electrons in an atom was derived in this way, and the result came out, though only rather roughly, to be about the same as the value of the atomic weight itself; at any rate, it could not be supposed that any appreciable part of the weight of an atom was contributed by its electrons.

Turning to radio-activity, the evidence becomes far more definite. Radio-activity consists in a succession of transformations of a substance through a perfectly definite series of states. Each state has all the properties associated by the chemist with the word "element," and it is only in the fact of their transmutability that the radio-active elements differ from the others. In the act of transformation each atom throws off a high-speed particle. The particle is characteristic of the element that is changing, and there are two different kinds, known as α- and β-particles. The α-particle is simply a helium atom carrying a positive electric charge equal to twice that of an electron. Its speed depends on the radio-element undergoing transformation, and in the case of the element known as Radium C has the enormous value of one-fifteenth of the velocity of light. The β-particle, on the other hand, is an electron, and its velocity is sometimes almost equal to the velocity of light itself. The speed of both types is so great that they can disregard entirely the impenetrable character of the atom, and go right through it. In doing so they will sometimes go very close indeed to one of the electrons in the atom, and will be deflected from their course by it. The β-particle will be easily deflected on account of its lightness, and indeed it is observed that, if a parallel beam of β-rays falls on a thin sheet of a substance, the emerging beam is scattered so that it is spread over a broad angle. Not so the α-particles. These are so massive, compared to the electrons, that they go right through everything practically in a straight line, and it requires the cumulative effect of a large number of electrons to produce a perceptible spreading of the beam. Experiments were therefore carried out in Rutherford's laboratory in Manchester to estimate the amount of this scattering. The results showed that for the substances examined the number of electrons in an atom was equal to about half its atomic weight.

In the course of the scattering experiments it was observed that a few of the α-particles underwent large deflections, much as do β-particles, and this observation furnished the key to the final solution of the problem. For an α-particle is so heavy that it requires the development of enormous forces to throw it off its line of motion, and these forces can only be caused by another body of large mass and charge. On these grounds Rutherford put forward his theory of atomic structure, which is now universally accepted. An atom has a nucleus of very small dimensions which carries practically the whole of its mass, and has a charge of positive electricity equal to some multiple of the charge of an electron. This charge is neutralised by a cloud of electrons surrounding it, and the number in this cloud, or (which is the same thing) the number of elementary charges in the nucleus, is the fundamental character which determines the chemical nature of the atom. Radio-active transformation is due to a change of the nucleus, and as some transformations give β-particles (which are electrons), the nucleus certainly contains electrons in itself; but these are merged in its total charge, and are not to be counted in estimating the number of electrons in the atom. Chemical processes are only strong enough to scrape off an electron or two, or to make some of the outer ones vibrate, and it requires X-rays or α- or β-particles to get inside and show the qualities of the nucleus and the inner electrons. The laws of the forces ruling in the atom, and still more in the nucleus, are almost completely unknown at present, and constitute one of the most important and difficult problems of physics.

To test Rutherford's theory, very intense radio-active sources were prepared so that considerable numbers of α-particles would be deflected to broad angles, and these numbers were counted. The results bore out the theory completely, and indicated nuclei of strength equal to a half or a little less than half of the atomic weight. This was found for gold, platinum, tin, silver, copper, aluminium, and carbon. An eighth case can be at once added, the α-particle itself. In the course of its violent history it is certain that any electron attached to it would be scraped off. In other words, it is itself the nucleus of the helium atom, and its charge, 2, is half its atomic weight, 4.

Now if the elements are numbered off, starting with hydrogen as 1, and going in order of their atomic weights, it will be observed that the resulting numbers are all (excepting hydrogen itself) half the atomic weight or a little less. So there is a very strong suggestion that it is this number that is really being given by the experiments. If the α-particle experiment were susceptible of a high degree of accuracy, we should have a perfectly direct way of counting what the exact number is in each case, and could in this way also discover any gaps in the series. But to get even rough results is very difficult, and fortunately, when the problem had reached this stage, a less direct but much more powerful method had been developed, which in the course of a very short time finished it off.

The experiments of Laue and his collaborators proved that X-rays were a type of light,[1] and the Braggs discovered that there was a characteristic spectrum emitted by the substance of the target of their X-ray tube. Moseley[2] developed an exceedingly powerful method of finding the characteristic spectrum of any substance, and in the course of a few months examined the majority of the elements. Whereas the visual spectrum of a substance depends on its place in the periodic table (for example, the spectra of lithium, sodium, and potassium all show a strong family resemblance), in the X-ray spectrum no periodicity is shown, and instead there is a perfectly orderly progression from element to element along the list. The structure of all the spectra is exactly the same, and the only difference is that each in succession has all the wave-lengths of its lines reduced in a definite proportion. Moseley's work extended throughout the region between aluminium and gold, and it has since been extended up to uranium. More remarkable still is the fact that, if the system is carried back to the beginning of the list, where no X-rays can be found at all, the spectrum corresponds to the ordinary visual spectrum of hydrogen.

Now here we have an absolutely certain way of counting elements, and Moseley of course took advantage of it. He at once showed that cobalt should come before nickel (this the less direct X-ray methods of Barkla had done already), and a little later that potassium comes next to calcium (argon, being gaseous, could not be tested), and that tellurium comes before iodine. He also confirmed the two "manganese" gaps predicted from the periodic table. He then turned his attention to the rare earths, and found that they do not differ from other elements in the least, but show the same orderly progression. His study revealed the extraordinary difficulties which face the rare-earth chemist. Salts of a rare earth warranted pure would be found to contain 80 per cent. of other rare earths. He examined all the specimens he could collect, and found 14 elements between lanthanum and tantalum, with one gap. Now it happened that at this very time Urbain, the most famous living specialist in this subject, himself the discoverer of several of the rare earths, thought that he had isolated a new one. Moseley's method provided an instant test, and Urbain therefore brought his specimen to Oxford to be examined. It was found to consist of a mixture of three known elements with no trace of the missing one.

Thus the outcome of Moseley's work is that there are definitely three and no more unknown elements between aluminium and gold. Two are somewhat like manganese, and would have atomic weights about 100 and 190. The third is a rare earth with atomic weight about 148. Below aluminium X-ray methods are inapplicable, but from the absolute regularity of the periodic table in this region, and above all from the correspondence of the X-ray spectra with the visual spectrum of hydrogen, there can be no gaps there. Thus we can with certainty number the elements, starting with hydrogen at 1 and ending with uranium at 92. There are five missing numbers—43, 61, 75, and in addition two more, 85 and 87; but the last are in the radio-active region, and we must turn to another type of evidence.

We have seen that radio-activity consists in a substance transmuting itself through a succession of states, each of which is a chemical element. The sequences are now well known, and all told something like forty transformations have been found. They all originate from either uranium or thorium, and there has long been very little doubt that they end their radio-active career as lead. The majority are never present in more than infinitesimal amount, but in a few cases they can be isolated and studied by ordinary chemical methods. Thus radium itself resembles barium, and so is naturally assigned a place under it in the periodic table. In spite of their resemblance, the separation of radium from barium is quite an easy process, but this is not so in the case of all radio-elements. Thus there is a substance called Radium D which is present in considerable quantity in uranium ores. It is always separated from the ores along with the lead. As it would be useful to have it as a radio-active source for some purposes, much effort has been expended in trying to purify it from the lead, but always without success. There are many other cases where substances, undoubtedly different from their radio-active behaviour, once mixed together cannot be separated or distinguished chemically or even spectroscopically.

Now consider how this fits in with our ideas of atomic number. We know of 43 different radio-active elements, but there are only 9 numbers available for them, those from 92 to 84. To reconcile these facts, the hypothesis of "isotopes" was put forward.[1] Isotopes are substances of different radio-active behaviour, but with the same chemical characters, and the hypothesis asserts that such will be quite inseparable by any chemical means. It will be seen that this fits in perfectly with the idea of atomic number, and it is now perfectly straightforward to see how the number will change in a transformation. For the emission of an α-particle involves a loss of 2, and so the atomic number will be reduced by 2 when it is thrown off. Similarly, a β-particle transformation will increase the number by 1, as here the particle is a *negatively* charged electron. If this principle is applied the whole system of radio-elements is cleared up, and a complicated chain can be worked out, starting with uranium at 92, and ending with lead at 82, some steps decreasing by 2 and others increasing by 1. A similar chain starts from thorium at 90, and also ends with lead. If these chains are examined, it will be found that most places are filled several times over, but that none of the elements fall into the places 85 and 87. These are the two other missing elements.

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[1] See any modern book on X-rays, for example W. H. and W. L. Bragg, *X-rays and Crystal Structure*.

[2] H. G. J. Moseley worked in Manchester and afterwards at Oxford. He was killed during the Suvla Bay landing at Gallipoli, serving as Signals Officer to an infantry brigade, an immense loss to science.

[1] Simultaneously by A. S. Russell, F. Soddy, and K. Fajans. The word "isotope" is due to Soddy, and implies the "same position" in the periodic table.

We next push the principle of isotopes a little further. If the weights of all the particles it emits during transformation are subtracted from the weight of a uranium atom, the result should give the weight of the end-product. There are 8 α-particles (the β-particles are insignificant in weight), and so the result should be $238{\cdot}2 - 8 \times 4 = 206{\cdot}2$. Now the end-product is lead, and its atomic weight is usually accepted as 207·1. This suggested determining the atomic weight of lead derived from radio-active ores, as presumably this lead would be partly composed of extinct radio-active matter, and the value found was 206·4, quite different from ordinary lead. This was the first definite attack on the chemist's faith in atomic weights. This faith has been shattered by the experiments now to be described.

It has long been known that, if an electric discharge goes through a vacuum tube (such a tube always contains a little gas), charged atoms are produced moving at high speeds, and so able to affect a photographic plate. These are called positive rays, from the sign of the charge they carry.[1] By means of electric and magnetic fields they can be deflected, and from the amount of deflection their weights can be found. Working on these lines, Thomson examined the atomic weights of many of the elements. In most cases the result fully confirmed ordinary chemical evidence, but in neon (atomic weight 20·2) it was consistently found that there was a faint line on the photographs corresponding to 22, as well as the line at 20. There was thus a strong suggestion that neon is composed of two isotopes, nine-tenths having an atomic weight of 20, and one-tenth an atomic weight of 22. Now isotopes cannot be separated by ordinary chemical means, yet any gases whatever can be separated by the physical process of diffusion if their weights are different. Aston therefore set to work to try and separate out a heavier type of neon. The method is very tedious, even when made self-acting, as many million operations are needed. After a long succession of trials he obtained faint indication of improvement, but not enough to encourage him to proceed. He therefore turned his attention again to positive rays, and with a greatly improved apparatus was able to prove that neon is certainly double, part exactly at 20 and part exactly at 22. Turning to other substances, chlorine seemed of special interest, as its atomic weight, 35·46, is nowhere near a whole number. He at once found that it is double, three-quarters at 35 exact, and one-quarter at 37 exact. In the same sense mercury was also found to be composite. These results are not two months old, and there the matter rests for the present.

It is impossible to see how far Aston's results will go, but a little speculation is irresistible. It looks as if we were going to find that all atomic weights are whole numbers after all. This is simply a new form of a very old idea, a forerunner of the periodic law, famous as "Prout's Hypothesis." The only difference is the important one that now an element may have more than one atomic weight. In terms of Rutherford's theory, this means that nuclei of the same total charge can be built up in different ways exclusively out of hydrogen atoms and electrons. For example, chlorine has number 17 and weight 35 or 37; so its nucleus is composed either of 35 hydrogen atoms cemented together by 18 electrons, or 37 hydrogen atoms and 20 electrons. When the corresponding facts have been explored for the other elements, they may perhaps throw a dim light on to the future problem of the structure of the nucleus.

Summarising our results, we have shown how the periodic law of the chemist has been replaced—it still remains to explain it—by the conception of atomic number—that is, the number of elementary charges of positive electricity concentrated on the nucleus of the atom. We have seen that, of the 92 elements from hydrogen to uranium, all are known except five, Nos. 43, 61, 75, 85, and 87. Looking back to the periodic table, we can say that 43 and 75 would bear a family resemblance to manganese, 61 would be a rare earth, 85 a halogen (i.e. one of the chlorine group), and 87 an alkali-metal. From another point of view we have seen that atomic weight is only loosely connected with atomic number, and it looks as though all nuclei were built up of hydrogen atoms and electrons exclusively. There is thus a curious inversion of the interests of chemist and physicist. The reverence of the chemist for atomic weight must cease, and in future he must venerate atomic number only. On the other hand, an exact knowledge of atomic weights will be one of the few guides the physicist will have in his investigation of the structure of the atomic nucleus, the main foundation of all matter.

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[1] An account of this subject will be found in Sir J. J. Thomson's *Positive Rays*.

England's "Peaceful Penetration" of Germany in the Middle Ages

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It has long been a matter of controversy with scholars to what extent German language and literature in the eighth and ninth centuries were indebted to Anglo-Saxon influence. A most important contribution to the subject, invaluable to the historian and the linguist alike, was published recently.[1] The essay is from the pen of the veteran "Germanist" Wilhelm Braune of Heidelberg, who with Hermann Paul, Eduard Sievers, and Friedrich Kluge, form a stalwart band of *Junggrammatiker* (alas! no longer young), a term used to distinguish them from the older school of Grimm and Lachmann and the great pioneers of last century. A life-long student of Old High German Language and Literature, he is famous in the modern language schools throughout the Old and New World as the author of the standard Grammar and Dictionary of Old High German. These have made him the greatest living authority on the oldest periods of German, and it is only fit and proper that he should be the author of one of the most interesting philological discoveries of modern times.

It is well known that the conversion of Germany was undertaken by a native of Devonshire, the Anglo-Saxon Wynfrith, famous in the annals of the Church as St. Boniface. In A.D. 719 he was commissioned by Pope Gregory II to the heathen nations of Germany, and laboured unceasingly as a missionary for thirty years. The founder of cathedrals and bishoprics, Archbishop and Primate of all Germany, Wynfrith resigned dignities and honours that he might devote himself the more effectively to his great mission. In 754, whilst holding an open-air confirmation service in Friesland, the "Apostle of Germany" won the martyr's crown. His remains were eventually brought back to Germany, and buried in the celebrated monastery of Fulda, which he himself had founded.

The Anglo-Saxon mission in Germany, however, began even earlier. Its extreme limits date from the landing of Wilfrid in Friesland in 678 to the installation of Willehad as Bishop of Bremen in 787.[2] The anxiety of the English for their German brethren may be explained very largely to the fact that they still considered the latter (or at least the Saxons) to be of the same stock as themselves. Boniface, in urging his countrymen to undertake missionary work among the Germans, reminds them that they are people "of their own flesh and blood," and in the eighth century the Saxons in Germany were known in England as "Altsaxones."

The English mission reached its height with the intense activity of Wynfrith in Middle Germany. English priests came over, not in dozens, but literally in hundreds, and of the newly instituted benefices in Thuringia, Hesse, and East Franconia, most were held by Englishmen.

But their activity extended also to the South, and a great religious revival was instituted by Boniface in Bavaria under the auspices of Duke Odilo, with the result that many English monks were inmates of Bavarian and Alemanic monasteries. It is no wonder, therefore, that this great influx of Anglo-Saxon priests, with their superior "Kultur," should have influenced the intellectual life of the Germans in all directions. It made itself evident at once in the introduction of the Anglo-Irish Script, which maintained itself until the ninth century. It was naturally not to be expected that the monks would further the national heathen literature, but that the religious literature of Germany, and especially Old Saxon poetry, was largely written under Anglo-Saxon inspiration is now an accepted fact. To what extent Old High German literature itself stands indebted to Anglo-Saxon poetry is still a moot question; the most extravagant claims have been made, but without meeting with general acceptance. But part, at least, of the *Vocabularius St. Galli*, the famous dictionary of the monastery St. Galli in Switzerland, dating from the middle of the eighth century, can be proved to have been based on an Anglo-Saxon model, whilst the *Baseler Recepte* show an admixture of Anglo-Saxon forms. Even the vocabulary of the Old High German translation of Tatian's Harmony of the Gospels contains no fewer than two hundred and eighty words which do not occur in other High German Sources, but are peculiar to Anglo-Saxon or Low German districts.[1]

Thus whilst the certain examples of the influence of Anglo-Saxon on literary German are restricted to a few solitary instances, yet Anglo-Saxon phraseology certainly influenced most powerfully the living spoken language. The English missionaries, in their efforts to expound the new doctrines, had to coin many new words and expressions (when they naturally turned to such terms as were familiar to them in their own tongue), or place a fresh interpretation upon the old. Now there existed already before the advent of Wynfrith an older stratum of Christianity, due to Latin, i.e. Roman, influence between the fifth and the seventh centuries. It was naturally to be found in those parts of Germany which had formerly been under the sway of Rome—i.e. in the South, and in the Rhine districts. But cut off as they were (in the South at least) from Christian intercourse, and encompassed all about with heathen tribes, these Christians had fallen sadly away from the pure faith, and their belief teemed with errors and superstitions. Yet Christianity had flourished long enough in these regions to give rise to a new terminology, which had thus been in existence for some hundreds of years when the Anglo-Saxon missionaries entered the country.

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[1] *Beiträge zur Geschichte d. deut. Sprache u. Literatur*, 1918, vol. xxiii, pp. 361 et seq.

[2] See *Kirchengeschichte Deutschlands*, vol. i, pp. 448–594, by A. Hauck; also *Deutschland und England in ihren kirchlichen Beziehungen*, by the same author.

[1] This translation was written in the monastery founded by Wynfrith at Fulda.

We notice, then, in many cases a duel between two expressions, the one German, the other English. Thus the English found the Latin loan-word *kruzi* (crux, crucis) already so firmly established that their *ród* (rood) could make no headway. So, too, the High German *opfaron* (Mod. German *opfern*), borrowed, as the operation of Grimm's Law shows, at an early period from the Latin *operari*, held its own against the interloping Anglo-Saxon *offrian* (from the Latin *offerre*), of which only a few instances occur in Old High German; the O.E. *gotspell* (gospel) competed for a time with the Latin *evangelio*, but the latter won the day. In the above-mentioned Tatian translation we find the word *sibba* with the Anglo-Saxon meaning of "peace," instead of the usual sense of relationship which it has preserved in Modern German; nor could the adjective *ôdmustig* (O.E. *éaðmód*), which occurs quite commonly in the Rhine-Franconian author Otfrid, displace the Upper-German *desmuoti*, which has subsisted in the Modern German *demutig*.

Occasionally, however, and in some very important and interesting examples, the Anglo-Saxon word completely supersedes the German expression. Thus there were two Germanic words corresponding in meaning to the Latin *sanctus*, both occurring in Gothic as *weihs* and *hailags*. In England the form *wéoh*, with its cognate word *wíȝ* (idol), was apparently obnoxious to churchmen on account of its connection with the heathen cult.

And so the Latin *sanctus* was, in an ecclesiastical sense, translated by *háliȝ*, and the adjective corresponding to *wíȝ* was quietly dropped. In Old High German, on the other hand, the term *wîh* had obtained almost complete mastery over *heilac*, which was only used in the old meaning of inviolate, intact. The common ecclesiastical phrase was *wîh*, as we know from the earliest glosses for *sanctus*. In a short time, however, under the influence of the English mission, the O.E. *háliȝ* completely ousted *wîh*, so that even as early writings as those of Tatian show no trace of it. It has only survived in Modern German in a few formal expressions like *Weihnachten* (*zen wîhen nahten:* at the holy nights), in *Weihrauch* (sacred smoke, i.e. incense), and in a few Bavarian place-names like Weihenstephan, Weihenzell.

Similarly the English churchmen translated the Latin *spiritus sanctus* by *háliȝ ȝást*. *ȝást*, German *Geist*, was a word common to all the West German dialects, and seems to have had the primitive meaning of "apparition" (cf. our English *ghost*). It was certainly in this sense that the word existed in High German, for the phrase already adopted by the South German Christians was *wîh atum* (Mod. German, *Atem*). But so thorough was the Anglicising of German ecclesiastical terminology that *der heilige Geist* is still to-day the only designation for the third Person of the Trinity, while *Atem* has ceased to be current with the meaning of "Spirit" since the end of the twelfth century.

Equally, or even more significant, is the fact that the German name for the greatest Christian festival is of undoubted Anglo-Saxon origin. Whereas all the Germanic peoples denote Easter by variants of the loan-word *pascha* (Gothic *paskia*, Middle Low German *pasche*, Middle Dutch *paeschedach*, Old Frisian *pascha*, Old Norse *páskar*, Swedish *pask*, Danish *paaske*), the English and Germans (i.e. the High Germans) alone know the festival as Easter or *Ostern*. The etymology of the word occupied the attention of no less a person than the Venerable Bede, who, in 725, stated that the Eostur-monath was so named after a feast of the heathen goddess Eostrae, which fell near the time of our own Easter.[1] And though this explanation has been scouted by some scholars, yet the fact that similarly Yule (O.E. *ȝéol*) was originally the feast of the winter solstice, and was afterwards Christianised, would seem to support Bede's statement.

We have seen how the English in the train of Boniface were numerous and influential enough to change the very language of their converts for all time, and in some very important respects. But the climax is still to come. The very name by which the Germans speak of themselves to-day, the word *deutsch* as a description of the whole German people, is of English origin. That *deutsch* goes back to an adjectival form *diutisch*, itself derived from *deot* (A.-S. *þéod*), meaning the people in its totality, is an incontrovertible fact. But it is equally certain that the adjective *diutisch* does not occur in German until Notker uses it in the first half of the eleventh century. When Otfrid, in the first half of the ninth century, wished to give expression to the notion of his own German tongue in contrast to Latin, he, being a Franconian, used the expression *frenkisg*. In other words, he had no conception of a German language (or of a German people either for that matter) apart from each tribal dialect. On the other hand, a foreigner like St. Boniface must have been sufficiently conscious of the distinction of his own language from that of his converts, and was in a better position than a native to visualise the people as a separate entity. And there is considerable evidence to show that the learned term *theotiscus*, which in its earliest use is always applied to the language, and on the analogy of which the German *diutisc* was formed, was an invention of the Anglo-Saxon mission, and formed on the model of their own *þeodisc*—i.e. of, or belonging to, the people. At all events the first use of the term occurs in 786 in a Latin document referring to an English synod.

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[1] See Chapter XV of Beda Venerabilis, *De tempororum ratione; De mensibus Anglorum.*

From 788 onwards the Latinised term *theotiscus* is common in Germany in the special sense of applying to the conglomeration of German dialects as a whole in contrast to Latin. It seems quite likely, as Braune suggests, that the first incentive to its use with this particular meaning went out originally from the Anglo-Saxon Wynfrith, who as spiritual head of the German Church had need of a single term to denote the language of his whole people.

Gravitation and Light

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During the past few months, much attention has been given in the Daily Press and elsewhere to what is known as the "Generalised Theory of Relativity." The average person who has endeavoured to follow the discussion which has ensued has doubtless acquired but a very hazy notion of the nature of this theory: he will probably have concluded, however, that so much discussion can only have been caused by a theory which marks a definite epoch in scientific thought. The theory, which has been developed by a Continental physicist, Professor Albert Einstein—whose name is now a household word—does, in fact, revolutionise our conceptions of space and time.

The present article is not concerned with this theory, but with the discovery which attracted general attention to it and started the discussion. This was the proof that the path of a ray of light is bent when it passes near matter. Whether Einstein's theory is true or not—and men of science are divided into two camps on that question—it cannot be denied that this result has been definitely established by recent astronomical observation. Its importance is due to the fact that it is the first new thing which we have been able to learn about gravitation since the master mind of Isaac Newton enunciated the law of gravitation more than two hundred years ago.

Newton's law of gravitation states that any two particles of matter attract one another with a force which is proportional to the product of their masses, and inversely proportional to the square of their distance. Expressed mathematically, if m, m^1 are the masses of the two particles and r their distance apart, the force of attraction between them can be written kmm^1/r^2, where k is a constant called the "constant of gravitation," which is the same for any two particles. Newton showed that this law was satisfied by the motions of the planets round the sun, the laws of which were stated by Kepler, and also that it governed the motion of the moon around the earth. The increasing refinements of astronomical observation have since served to increase our confidence in the law and its universality, and the discovery of the planet Neptune, the story of which is so well known, was a further triumph for the law.

Yet, strange to say, until a few months ago our knowledge of gravitation still stood where Newton left it. Although so universal, and governing every action of our daily life, it has remained aloof from the other forces of Nature. We have gained more or less clear conceptions of what constitutes sound, heat, light, electricity and magnetism, and of the properties of material bodies such as elasticity, cohesion, rigidity, etc., but only now has the barrier of gravitation been broken down.

It is a tribute to the sagacity of Newton that he foresaw the manner in which this barrier might be broken down, for in his *Opticks* we read: "Query 1.—Do not bodies act upon light at a distance, and by their action bend its rays, and is not this action strongest at the least distance?" Newton, of course, believed light to consist of minute corpuscles emitted by a body, and it was therefore to him a logical possibility that the corpuscles might be attracted by matter and fall towards it in a similar manner to that in which the bullet from a rifle falls towards the earth. However, Newton was not in a position to establish his query. That was left for the twentieth century.

We will explain first the observed phenomenon, and then the manner in which it was established.

In Fig. 1, suppose S to represent the sun, E the eye of an observer on the earth, and P a star which is seen by the observer close to the sun's edge. The figure is not

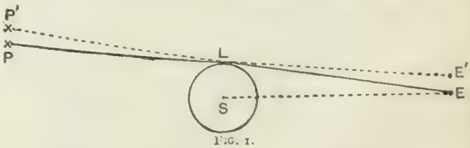


Fig. 1.

drawn to scale: if it were, and SE were taken as representing 10 inches, then the diameter of the sun would be $\frac{1}{10}$th inch, and the distance SP, for a near star, would be something like fifty miles. Then the result which has been established is that P, L, E do not lie in a straight line, the rays of light from the star being bent by the gravitational action of the sun, so as to consist practically of two straight portions PL, LE. The rays coming to the observer along the direction LE cause the star to appear at P^1 in EL produced. The ray from the star if it were not bent would come to E^1 instead of E, and the distance EE^1 may be used as a measure of the deflection of the light. On the scale which has been mentioned above, in which SE is 10 inches, the displacement EE^1 would be about the ten-thousandth part of an inch. Expressed otherwise, the angular displacement, which may be measured by either the angle ELE^1 or the angle PLP^1, is 1·75 seconds of arc. A second of arc is the angle which would be subtended at the eye by a halfpenny at a distance of three miles.

These figures apply in the case of a star, the light from which just grazes the edge of the sun. For stars appearing further from the centre of the sun the deflection is less, its magnitude varying inversely with the distance from the sun's centre. Thus, for instance, if the apparent distance of the star from the sun's limb or edge is equal to the sun's radius, the deflection will be 0″·87, i.e. 1″·75 divided by two. If it is at twice this distance from the limb (i.e. at a distance equal to three radii from the centre), the deflection will be 0″·62.

Owing to the great brightness of the sun, it would of course ordinarily be quite impossible to see stars so near the edge of the sun. Moreover, the amount of the deflection anticipated (and predicted by Einstein) is so small that the only body with a large enough mass to use for the purpose is the sun. It would require a precision far exceeding the highest so far attained in laboratory measurements before the effect could be established by means of laboratory experiments. The only remaining possibility is to take advantage of a total eclipse of the sun, when the moon comes between the earth and the sun, blotting out the light from the latter. When a total eclipse occurs, complete darkness does not ensue, as there is then seen around the sun a fringe of bluish-white light called the solar corona (see Plate), which has a brightness somewhat exceeding that of the full moon, and which cannot be seen at any other time. The nature of the corona is not completely understood, as its shape varies considerably from one eclipse to another. It is known, however, to consist of gaseous matter in a state of great rarefaction; the principal element in it has not yet been discovered on our earth, and has therefore been termed coronium.

Even when a solar eclipse occurs, the stars near the sun will not in general be sufficiently bright to be visible to the naked eye, and we must call to our aid the photographic plate. By giving an exposure of sufficient length, the plate will accumulate the light impressions which it receives, and so render even faint stars visible.

Total solar eclipses do not occur very frequently; the last occurred on May 29, 1919, and the next will occur on September 21, 1922. Moreover, they are only visible over a very limited portion of the earth's surface. The apparent diameters of the sun and moon are so nearly equal that the shadow of the moon cast by the sun at an eclipse is in the form of a very elongated cone, whose point or apex is near the earth's surface; the section of this cone by the earth is therefore a region not covering very many square miles. As the moon and earth move relatively to the sun, the shadow traces across the earth's surface a narrow band, and it is only at points on the earth's surface within this band that a total eclipse of the sun is visible.

The total eclipse of May 29, 1919, was a peculiarly good one for the purpose of these observations, as the sun then happened to be in a region of the heavens containing an unusually large number of bright stars. In fact, if the course of the ecliptic—i.e., the apparent path of the sun in the heavens during each year—be traced on a star map, it will be found that no more favourable opportunity could have occurred. It will not occur again for a few hundred years. The eclipse track on this occasion crossed Brazil and the Atlantic Ocean, passed over the Island of Principe, and crossed Africa from Cape Palmas in Liberia to Lake Tanganyika. It was arranged by the Joint Permanent Eclipse Committee of the Royal and Royal Astronomical Societies that two expeditions should be sent out to secure the necessary observations, and in order to reduce the risk of bad weather spoiling the observations, it was decided that one party should proceed to Sobral, in the State of Céara, Brazil, and another to Principe. The conditions in Liberia appeared too unfavourable, although, as events turned out, the conditions there during the eclipse were much superior to those which obtained in Principe. The observations at Principe were spoiled by light cloud, which partially obscured the sun throughout totality; the plates taken were useful, however, as serving to confirm the results obtained by the Sobral observers. At Sobral, the region of the sky around the sun was clear for the greater part of totality, but for the remainder it was veiled by thin cloud.

Two series of photographs were obtained with two different instruments. For the sake of brevity, we will refer only to the better series of the two. A photographic camera was used whose lens had an aperture of 4 inches, and a focal length of 19 feet. The telescope was not pointed directly to the sun, but was for convenience supported in a fixed horizontal position and fed by an 8-inch coelostat. The latter consists essentially of a plane silvered mirror, which is turned by clockwork about an axis parallel to the axis of the earth's rotation, and at such a rate that the light from the sun is always reflected in the same direction. The photographic plates used measured 10 by 8 inches. The focus of the instrument was carefully adjusted, first by visual observations, and then finally photographically by a series of exposures on a bright star. Eight plates were obtained with this instrument during totality, each having an exposure of 20 seconds. When these plates had been developed, it was found that, with a single exception, they all showed images of seven stars, the remaining plate having been spoiled by cloud. The images were round and sharply defined, and suitable for accurate measurement in a micrometer.

In order definitely to establish the existence of a deflection, it is of the utmost importance that the scale of the photographs should be determined with the highest accuracy possible—i.e., the equivalent value in angular measure of, say, 1 mm. on the plate must be known. To provide material for determining this, the same region of the sky was photographed a few months later with the same instrument, none of the adjustments having been changed in the meanwhile, and the sun by that time having moved sufficiently far from the field for photographs to be obtained in the early morning before sunrise. These photographs were taken when the star-field was at approximately the same height above the horizon as it was during the eclipse: this ensures that the effects of refraction on the positions of the stars are very approximately the same on the two series of plates. An additional photograph of the field was also obtained on another plate through the glass—i.e., the back or non-sensitised side of the plate was turned towards the field—so that on development the star images appeared reversed: if this plate, which we will call the key-plate, and one of the other plates were placed film to film, the corresponding star images were approximately superposed. This considerably simplified the process of measurement, as will now be explained.

The key-plate and one of the other plates were placed films together in a measuring apparatus. The latter consists essentially of a frame for carrying the photographs which can be moved up and down on a slide: the plates are viewed by a microscope which is capable of movement along a slide parallel to the plate, but perpendicular to that just mentioned. Any part of the plate can therefore be brought into the field of view of the microscope, and the two films being in contact, the star images on each are in focus at one and the same time. The distances apart of the two images did not exceed one-third of a millimetre, and this distance was measured for each star by means of a micrometer in the eyepiece. By comparing first an eclipse-plate and then a scale-plate successively with the key-plate, the relative differences in position of the stars between the eclipse- and scale-plate could be at once obtained. For convenience, the components of the differences in two directions were measured, viz. in right ascension and declination. The latter direction is that joining the star to the pole; the former the direction perpendicular to this, or, in other words, the direction in which the star apparently moves, owing to the rotation of the earth. In this way, each eclipse-plate was compared with a corresponding scale-plate, and by a process which need not be elaborated here, but which is not quite so straightforward as it may apparently seem, the effects due to scale and deflection are separated, and the displacement of each star determined.

It is important that the magnitude of the quantity which is being sought should be grasped. One second of arc corresponds to about one-thousandth of an inch on the plates, and the star images themselves are about three seconds of arc in diameter. The greatest calculated displacement for any star on the plate was somewhat less than one second. Yet these quantities are capable of accurate measurement, and, in fact, the plates were measured independently by two different persons, who obtained substantially the same results.

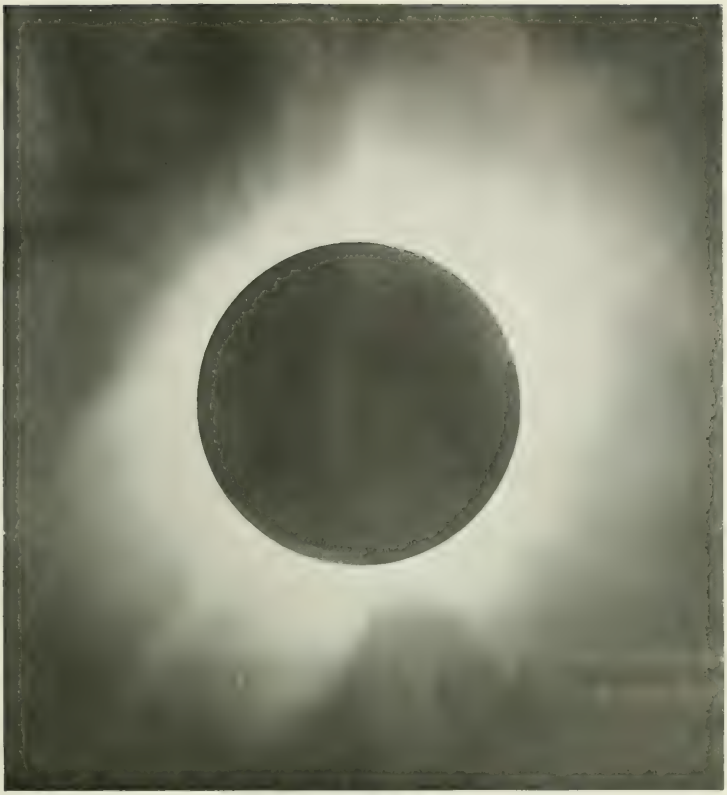
The results may be summarised in the following table:

Star No.	Displacement in Right Ascension.		Displacement in Declination.	
	Observed	Calculated	Observed	Calculated
11 . .	− 0″·19	− 0″·32	+ 0″·16	+ 0″·02
5 . .	− ·29	− ·31	− ·46	− ·43
4 . .	− ·11	− ·10	+ ·83	+ ·74
3 . .	− ·20	− ·12	+ 1·00	+ ·87
6 . .	− ·10	+ ·04	+ ·57	+ ·40
0 . .	− ·08	+ ·09	+ ·35	+ ·32
2 . .	+ ·95	+ ·85	− ·27	− ·09

The first column of this table contains the reference number of each star, and the following columns contain the measured and calculated displacements in the two separate directions. The latter are calculated according to the formula $1''{\cdot}75/r$ where r is the apparent distance of the star from the centre of the sun measured in terms of the sun's radius as a unit.

In view of the smallness of the quantities sought for, the agreement is remarkable, the discordances being well within the limits of measurement. The displacement at the limit given by these measures would be $1''{\cdot}98$, somewhat larger than the amount predicted by

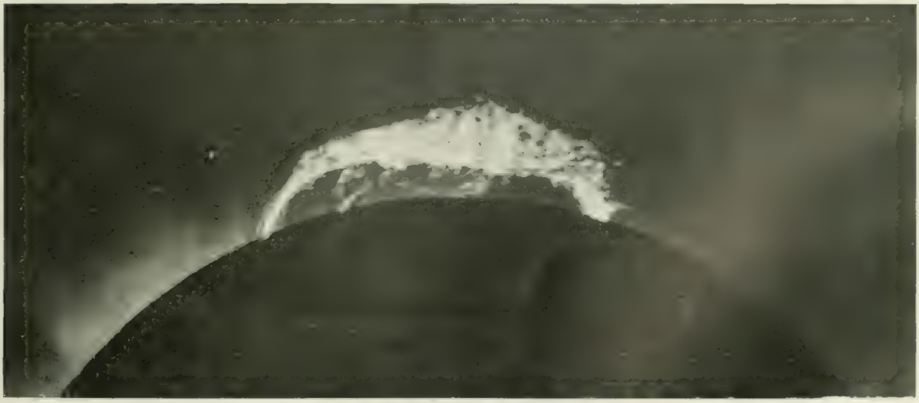
PLATE I



SOLAR CORONA MAY 29, 1919.

(*Photographed at Sobral, Brasil. Exposure 28 [illegible].*)

PLATE II



LARGE SOLAR PROMINENCE: MAY 29, 1919.

(*Photographed at Sobral, Brasil.*)

Einstein, but the excess may be due partially or entirely to a refraction effect by the solar corona.

Astronomers, who are familiar with the errors incidental to the measurement of astronomical photographs, accept the evidence as definitely establishing the existence of the deflection; and their verdict has naturally been accepted by scientists in general. Many attempts have, however, been made to show that the deflection can be attributable to other causes than the sun's gravitation. We have not space to enter into these here, but we may add that, in the opinion of those most competent to judge, these "explanations" are invalid, and for the most part extremely artificial. The present writer believes that the deflection can be attributed only to a direct effect of the sun's gravitational field, and that the answer to Newton's query is therefore "Yes."

Although not the special purpose of the expeditions, it may be mentioned that incidentally some excellent photographs of the solar corona were secured. In the Plate is reproduced one of the photographs taken at Sobral, showing the corona around the obscured disc of the sun. The star images do not show in the reproduction, being too small to appear. The lower photo shows the large prominence which was on the sun's eastern limb at the time of the eclipse. Its mean height is about 120,000 miles, and its length about 380,000 miles. Prominences can, by the use of special apparatus, be observed at times other than eclipses, and this particular one was under observation at the Yerkes Observatory for some time prior to the eclipse. Shortly after the eclipse, the prominence broke up, and within a few hours the greater part of it had rapidly ascended to a height of over 400,000 miles. Prominences consist mainly of incandescent hydrogen gas, and are connected with the disturbances occurring within the sun, which are also evidenced by sun-spots. The exact nature of the physical causes underlying their formation is not known. The prominence of May 29, 1919, was much larger than the average, and never before has so large a prominence been photographed during an eclipse. The splendid photographs obtained of it were a welcome by-product of the eclipse expeditions.

The Cambridge University Press have undertaken to publish a new work, entitled *The Cambridge Ancient History*. This work, of which the general plan will be similar to that of the *Cambridge Modern* and *Mediæval Histories*, will consist of eight volumes, and, beginning with an account of archæological discovery, will trace the history of Egypt and Babylonia, Assyria and Persia, Greece and Rome, to A.D. 324.

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The Stamp Act of 1765

I. The Conditions and Circumstances Preceding the Act

By C. H. K. Marten, M.A.

Assistant Master, Eton College

THE year 1765 is one of the most memorable in the history of the world. It saw the invention of Watt's steam-engine; and it witnessed the passing of the Stamp Act devised by England's chief minister, George Grenville. Watt's invention revolutionised the conditions of industry, and, in consequence of Stephenson's development, the means of communication; Grenville's unfortunate Act was the beginning of the disputes and misunderstandings which led to the foundation of the United States of America. And the Stamp Act still lives. It still helps to poison the relations between Great Britain and America. An English writer, fresh from his impressions of a recent visit in America, says "that the alleged selfishness and injustice of the Mother-Country constitute the history and traditions of America"; and an American, who has recently published a pamphlet on the school textbooks used in America, shows that some of them, old themselves and based on obsolete histories, still help to prejudice the rising generation against Great Britain. Many of us remember from our own school-days that we regarded England as the wicked dragon in the story, and America as the innocent fairy. And we comforted ourselves with the reflection that, after all, Grenville was but a pedantic lawyer, and the representative of what we considered to be a corrupt aristocracy, whilst George III was the son of a German mother who had dinned into him German ideas on the omnipotence of kings, ideas which were far removed from those held by most Englishmen at that time.

Of late years, however, the whole story of England's relations with her Colonies has been reinvestigated. And it is a happy example of the impartiality of historians that the inquirers, both in England and America, seem to be unaffected by their nationality. Indeed, it is not a little curious that the most convinced believer in England's wrong-headedness, amongst recent writers on the American Revolution, should be an Englishman, Sir George Trevelyan; whilst for more tolerant views of the policy pursued by the Mother-Country we must go to American historians such as Mr. G. L. Beer or Mr. O. M. Dickerson.[1] The present article agrees with the more tolerant writers. England may have been injudicious and bungling in her policy; she certainly had no intention to be unjust. And the circumstances at the time of the Stamp Act were so difficult that it is fairer, perhaps, to put the blame for the disputes upon them rather than upon the pedantry of George Grenville, or the obstinacy of George III, or the "umbrageousness"—to use Pitt's word—of American extremists.

What were the conditions and circumstances which made Grenville's position so difficult? The *first* was the *want of unity*, due to historical conditions, of the thirteen American Colonies which stretched along the American seaboard. They were of different origin, different occupations, even different climates. Their patriotism was local and confined to one Colony; and there were continually disputes between the Colonies as to their respective boundaries. "Fire and water," said a traveller in 1760, "are not more heterogeneous than the different Colonies in North America." As a consequence all attempts—and attempts had been made, as, for instance, in 1754—to get the Colonies to combine for defence had failed; and the Mother-Country had had continually to interfere to settle boundary questions and disputes with the Indians.

The *second* condition which involved difficulty was the old colonial system. Great Britain had not worked out satisfactorily in detail the principles which should control the relations of the Mother-Country and the Colonies; and these relations had developed in somewhat haphazard fashion. Perhaps Great Britain was to blame for this, but, after all, that is her British method, and there is a great deal to be said for it; and even now in 1920 we have not got a rigid system. Let us take, as an example, in the eighteenth century the three most important departments of Defence, Trade and Government—in all of which danger of friction lurked.

In Defence, Great Britain did far more than her share. She was wholly responsible for naval defence; she provided convoys, protected the Colonies from the French, Spaniards, and not least the pirates.[1] She kept garrisons, chiefly at her own expense, in the danger spots; she gave arms and ammunitions to the Colonies for local Indian wars. Finally, in time of war she assumed the chief burden.

Then in Trade. The old idea of historians was, in the words of Sir John Seeley, "that Mother-Countries regarded Colonies as merely estates out of which the

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[1] *British Colonial Policy*, 1754–65, by G. L. Beer (1907); *American Colonial Government*, 1696–1765, by O. M. Dickerson (1912). Of earlier writers Lecky's chapters, written soon after 1880 in his *History of England in the Eighteenth Century*, are a triumph of impartiality.

[1] We had an arrangement, for instance, with the Barbary pirates in the Mediterranean by which they left immune the ships of Great Britain and her Colonies. When the American Colonies became free, the Barbary pirates, by their captures, quickly reminded the Colonies of the more unpleasant aspects of independence!

Mother-Country was to make a pecuniary profit." But recent historians have taken a much more favourable view of Mother-Countries in general, and of Great Britain in particular. Thus Mr. G. L. Beer, the American historian, has put forward a good case in his attempt to show that the primary object of the British colonial system was to develop the wealth and power of the Empire as a whole, and to make it self-sufficing. The system was based on mutual reciprocity; it was, as the French called it, "Le Pacte Colonial." It was, for instance, a grievance, perhaps, to the American Colonies that they were only allowed to send their tobacco to England. But, on the other hand, Englishmen were only allowed to smoke Virginian tobacco; and when in 1661 Gloucester, Worcester, and Herefordshire tried to grow tobacco plants of their own, British troops were sent to destroy them. Perhaps England in the various arrangements was a little selfish and got rather the better of it. The making of hats in America, for instance, was forbidden owing to the Company of Hatters in London getting the Government to act; and great care was taken to prevent competition in the Colonies with the woollen exports that came from England. And it was certainly an aggravation that all goods from Europe to America had to go via England. But, at any rate, the English system was more liberal than that of any country. Moreover, the Colonies seem to have acquiesced in the system, though of course there was grumbling on particular points. Finally the Colonies evaded certain of the regulations by systematic smuggling; and you never could get a Colonial jury to convict a smuggler any more than you could in Sussex or in Scotland.[1] Both in the trade regulations however, and in their evasion, dangers lurked of which we shall say something later.

Then with regard to the Government. The details varied in each Colony. But, speaking generally, we may say that each Colony had a Governor, either appointed or approved by the Crown. The Governor was supposed to carry on the administration; he possessed a veto on legislation as did also the Crown at home—a right which the Crown seems to have used, not indeed unfairly but freely, as a total of 400 laws disallowed in 100 years indicates. Each Colony had a Council, a sort of Upper House nominated or approved by the Crown; and an elected Assembly with power of taxation. Now between 1700 and 1750 a remarkable transformation had occurred in the government of the Colonies. If the first half of the seventeenth century saw the successful fight for self-government in England, the first half of the eighteenth century saw

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[1] A man was charged with smuggling soap from Ireland direct to Jamaica; and the jury decided it was a foodstuff, and hence legal, because one witness said a man could live on soap for a month!

[*Continued on p.* 54

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a no less successful fight for self-government in the American Colonies.

"By 1765," says Mr. Dickerson in his recent book, the nominated Councils "had been robbed of their chief legislative powers, judges and other officers had become dependent upon the Lower House; the Governors had been reduced to inefficient figureheads, dependent upon the Assemblies for their daily bread, and impotent to obey the orders they received from England. There are few stories more fascinating than the account of this gradual subversion of the old colonial constitution by our stubborn forefathers, and the substitution in its place of a Government which could be controlled independent of the Mother-Country." A Governor depended for his own salary, and for those of his various officials, on the popular Assembly; he had to consult the Speaker of that Assembly upon nearly all measures, and had to take his advice if he wished things to go smoothly. The Speaker became, in fact, almost the local Prime Minister. No doubt there were grievances. The power of veto was one; the deficiency and corruptness of some of the Governors sent from England was another; the slowness of communications and the dilatoriness of the Home Government was another. But when all is said, the Colonies were, as regards Government, in a far more favourable position than any other Colonies at that time in the world; and far more independent than the territories—or colonies—which the United States themselves controlled in later years!

The situation, then, in 1765 was a system of Defence which left too much to the Mother-Country; a system of Trade regulations which, from its very nature, was difficult to work fairly; and a system of government in which the American Colonies had obtained, through their own efforts, a position of independence which they were not at all likely under any circumstances to surrender.

The *third* feature which made matters difficult was the Seven Years' War.[1] That war had, owing to the genius of the elder Pitt, seen magnificent successes—Hawke and Boscawen had won two memorable sea victories at Quiberon and Lagos; Wolfe had won Canada on the Heights of Abraham; the English infantry had won the Battle of Minden on the plains of Germany. The Battle of Plassey had made us king-makers in Bengal, that of Wandewash had ruined the French ambitions in Southern India. But nevertheless that war was largely responsible for the loss of the United States. In the first place, by giving us Canada it had freed the English Colonies from the French danger; as Mr. J. R. Green put it years ago, "With the victory of Wolfe on the Heights of Abraham began the history of the United States." It is quite unfair, of course, to suggest that the Colonies were conscious that they could now rebel in safety; but the point of importance is that, when the difficulties did arise, they were able to take a far stronger position because they no longer required the help of the Mother-Country against the French. Secondly, the war had left England burdened with an enormous debt, very heavy taxation, and no security for the future, as it was known that France and Spain were preparing for revenge. And at the end of every war, as at the end of the Great War we have just been engaged on, comes the cry for economy. The largeness of the national debt makes people talk of national bankruptcy, and there is an unwillingness to incur fresh obligations. That was the situation of England in 1765, as in 1920.

And then came the *fourth* circumstance which brought matters to a head. There was a great rising of the Indians under the formidable Pontiac along the frontiers of Pennsylvania and Virginia. The country for twenty miles inside the frontier over a long distance was completely desolated and several forts were lost. The position was very critical. Eventually, after a long conflict of fourteen months, the revolt was put down, chiefly by British forces. The Colonies, owing to their want of unity and various jealousies, had done badly. Massachusetts, for instance, had refused to help at all; Connecticut with great reluctance had sent but 250 men. The failure of the Colonies to combine, and the possibilities of future difficulties with the Indians, forced the British Government to the conclusion that they must keep an army of 10,000 men in America. But the question at once arose who was to pay for that army? Would Great Britain, with her heavy debt and her prospect of future wars and her already undue burdens in the way of defence, undertake the whole cost of an army designed solely for the defence of the American Colonies? Could the Colonies, disunited as they were, be got to agree on some system whereby they should be responsible for part of the expense? If the answer to both these questions was in the negative, would the Colonies, flushed with success in the struggle for self-government and now free from the French menace, submit to taxation imposed from outside? Obviously the problem was a difficult one—how George Grenville dealt with it and how he ought to have dealt with it will be the subject of discussion in a second article.

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[1] The Seven Years' War (1756–63) was fought, it will be remembered, between Great Britain and Prussia on the one side, and France, Austria, and Russia on the other; and towards the close of the war Spain joined France and her allies.

Roman Trade Societies

By E. V. Arnold, Litt.D.

Professor of Latin in University College, Bangor

The history of past times always offers a rich field for discovery. Sometimes new records are disinterred, or old ones for the first time interpreted, as in the case of the arrow-head inscriptions on bricks or the palaces and temples of perished cities. More often discoveries are made by the combination of existing material; and this is particularly the case with the Roman Empire of the imperial period. Over great areas of Europe, Africa, and Asia Minor have been found scattered thousands of inscriptions bearing witness to the Roman civilisation of the time; and we have voluminous law books from which information of the same kind may be collected. Chiefly from these sources we are now able to reconstruct the history of Roman trade societies over many centuries, and even to trace in this connection a progressive development which seems to contain some elements of inevitability. The story of the trade societies may be said to reflect the whole history of the rise and decay of Roman civilisation.

We hear of certain societies or guilds in the earliest days of Rome; these are the so-called "colleges" of musicians, goldsmiths, dyers, tailors, tanners, coppersmiths, and potters. All these are travelling trades, and stand contrasted with the agricultural labourers and those who practised home industries.

The latter groups were sufficiently organised in the patriarchal household, with its family discipline and its daily religious observances. The musicians, dyers, and so forth felt the need of constructing some kind of family system amongst themselves. The first step was to select a protecting deity, such as Mercury or Minerva; the next to institute at least an annual festival, in which the honouring of the god was joined to the enjoyment of his worshippers. Thus the societies were concerned with religious and social interests, and only indirectly promoted the material advancement of the members of each trade.

For all that they were at first regarded with suspicion by the Roman Government, as possible centres of disorder or revolution. And, in fact, they played a considerable part at election times, at which an organisation always counts for more than an individual. Several times laws were passed to suppress the societies altogether, but they were never effective. When Octavian established monarchy at Rome after the Battle of Actium in 31 B.C., one of his first public acts was to place the colleges under control. He therefore required that each particular college should obtain authorisation from the Senate; for which it would need either to

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show that it was of ancient foundation, or that it served important public needs. From this time all societies existed by favour; and numerous inscriptions show us that the favour was eagerly sought. But that the societies still used their influence for political purposes appears from the inscriptions which still cover the walls of the disinterred city of Pompeii, of which a great number consist of appeals issued by trade societies on behalf of their favourite candidates.

The laws of the Roman Empire were not very strictly administered, especially as regards the working classes, and numerous colleges were formed without the permission of the Senate. From time to time efforts were made to repress these unlicensed colleges, but in the end a general licence was granted to all societies of poor men, who might meet once a month and make a monthly collection. Amongst the societies thus formed a great number were burial clubs: these aimed at purchasing burial sites, and maintaining upon them a temple, and often also halls for meeting or dining.

Throughout the first two centuries of the Christian Era the trade societies continually increased in number and importance, and the State learnt to rely upon them for the performance of all duties essential to the prosperity of the community, and in particular for the transport and distribution of food. During this period the societies maintained a voluntary character, and were essentially self-governed.

The inscriptions reveal to us with fair completeness the inner organisation of the society. The members might be "ordinary" or "honorary"; the latter did not necessarily belong to the trade of the college, but joined out of sympathy. In small towns two or more trades would combine to form one society. Ordinary members were usually elected by the general meeting, but sometimes by the committee; they had to pay an entrance fee. They were then formed into groups of about ten members, called "decuries"; each group was subject to a group-officer, or "decurion." In the larger societies ten decuries (roughly) were formed into "centuries" under the command of a "centurion." This form of organisation is clearly borrowed from that of the Roman army.

The supreme authority rested with the general assembly (*conventus*). It held regular meetings at fixed dates, and special meetings when called by the president. It made the rules of the society, controlled the administration, and fixed the dates of festivals; it supervised the finance, and authorised the setting up of statues and altars with their inscriptions. It elected its own officers, except that certain societies had electoral committees (*censores*), to which they deputed this duty.

The chief officer was called president or master (*magister*); the number of such officers varied from two to six, and they took turns in performing the duties of the office—that is, in presiding at the general meetings, and generally in guiding the affairs of the society. Although the humblest member might rise to be president, it was usual to select a man of means for the office. He might be expected to pay a substantial fee upon his installation, to give the members a banquet, or to present a statue or a building. Besides the president there were the trustees (*curatores*), the treasurer (*arcarius*), the secretary (*scriba* or *tabularius*), the marshals (*viatores*), and the chaplain (*sacerdos*).

In public celebrations all these officers were overshadowed by the "patrons" or "patronesses," men and women of high rank who interested themselves in the societies' affairs, and sought popularity and influence as a return for their public-spirited efforts. Naturally the most numerous and wealthy societies secured the most eminent patrons: so that, whilst all the societies were in principle organisations belonging to the humbler classes, there was amongst them every gradation of importance and wealth. Some of these societies had considerable landed property, and imposing buildings and burial-grounds; others struggled for a bare existence, and perished from time to time by the desertion of their members. All, so long as they maintained their existence, gave to the man who individually was humble and helpless the sense of security and importance in his corporate capacity.

But the time came when the State not only guaranteed the corporate existence of the necessary societies, but made membership of them compulsory on all citizens. Alexander Severus (about A.D. 230) prescribed that all men throughout the empire should be compulsorily enrolled in their respective societies. If their numbers were thus increased, their inner strength decayed. Compulsion was used because the societies were growing too weak to discharge their duties; and the root-cause of this weakness was the shortage of men throughout the empire. It was felt in every rank of society; and each order and profession therefore took steps to conserve its membership; and since each was associated with a particular town, the first step was to prohibit migration. Membership of a college thus became a burden instead of a privilege. If members escaped, it remained possible to confiscate their property; and so gradually all property was considered as belonging to the society, not to the individual. To recruit new members, sons were bound to the trade which their fathers had followed before them. The tighter the bonds, the more frequent were the efforts made to escape from them: men fled from the towns to the mountains and the desert to escape from their duties.

Thus the life of the towns became completely disorganised; in the country-districts the change was less violent. Landowners offered refuge to the runaway townsmen on condition of service, and they were glad to accept a position which was practically that of serfs attached to the soil. But the landed estates could offer no resistance to the invasions of the barbarians; and the friendly societies, after a century or more of decay, finally perished in the general fall of Roman civilisation

The city-life of the Roman Empire in the third and fourth centuries A.D. has some analogies to the ideal of the Socialistic State. Certainly every trade was under State control, and its direct purpose was the prosperity of the city; and at the same time proprietors and employers were deprived of all profits, and in fact became poorer year by year. But the analogy must not be pressed too far; the centuries referred to are those of the general decline and fall of Roman civilisation, of which the direct causes were war, famine, and pestilence. The experience goes to show that State control of industries is not a panacea for every national or social evil; but we hardly know enough of the circumstances to judge whether, in fact, it proved a mischief or a support to the tottering empire.

But if we look back to the two preceding centuries, we find in the societies the happy outcome of a widely diffused sentiment of sympathy and humanity. There is no indication that the societies were at any time a nursery for class hatred, and they were not for any long period centres of political disturbance. The rich and the poor, the free and the slave, met within these organisations on a temporary equality; and gaiety and good-fellowship prevailed at their monthly assemblies. There is perhaps something for us to learn from these experiments in the past; and the early history of the Christian community cannot be rightly understood till it is recognised that it was in its beginnings one friendly society amongst many others.

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"Industrial Gases"[1]

It is with the deepest regret that we record the death of the author of this book. Dr. Greenwood was one of the most vigorous and promising of our young chemical

[*Continued on p.* 58

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[1] *Industrial Gases*, by Dr. H. C. Greenwood. Baillière, 12*s*. 6*d*. net.

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engineers. He was trained in Chemistry at Manchester, and worked subsequently under Professor Haber at Karlsruhe in Germany. During the war he was on the research staff of the Ministry of Munitions, and his chief work for this body was in connection with the production of ammonia from the elements nitrogen and hydrogen which compose it. This is the basis of a process of great importance, and it is largely due to his technical and executive ability that a sure foundation for the future development of this industry in this country has been laid.

. . . . .

This is a book which everyone interested in the technology of industrial gases should hasten to procure, and indeed it is a book worthy of a place on the shelf of any who are earning, or intend to earn, their livelihood in the profession of Chemistry. Much of the book is of interest to the general reader who is not averse to skipping at times, for it deals with many matters that one should know about, and which will repay study.

In the first part of the book the gases of the atmosphere are described in detail. Naturally enough the important things receive the most attention, but the rarer gases of the atmosphere, which to many are of greater interest than the commoner ones, are also well described. There is one " small fact " to which, although it is not new, we may call attention—namely, that the presence of ozone can have nothing to do with the bracing effect of seaside towns. The amount of ozone in the air at the surface of the earth is only about one part in ten million !

In the second part of the book an account is given of important gases like hydrogen, carbon monoxide, carbon dioxide, and the poison gases used in warfare. The third part deals with gases which are used industrially as fuels.

. . . . .

Before the war the knowledge of the average man with regard to poison gases was not an extensive one. Poisons were associated in his mind with the chemist's shop, the extermination of rats, a post-mortem at Hoxton, or with a murder case at the Old Bailey. Prussic acid was the best known. The young man blighted in love raised the phial of this accursed drug to his lips, and so deadly was its vapour that he passed over, as the Spiritualists say, ere his lips came in contact with the liquid. East-end practitioners, bothered by bibulous charwomen in their surgeries, kept their whisky in large green bottles labelled " Prussic Acid." (Such is a practical use of scientific knowledge !)

The only poison gas commonly known was the domestic sort, which certainly had a detrimental effect on the system when (in absence of a lighted taper) it was turned full on in a badly ventilated room.

But the war has changed all this. The Germans made use of poison gases as a weapon of war, the Allies retaliated, and a new art of warfare, the science of gassing, came into being. To Dr. Haber, whose work on gases gained for him the Nobel Prize in Chemistry of last year, much of the development of this art is to be ascribed.

The first use of poison-gas in warfare was made in April 1915. The gas used was chlorine. This gas was liquefied behind the line in large heavy cylinders. These were carried into position by perspiring Teutons, and disposed at regular intervals along the line. At a given signal, on a day of favourable wind, the gas was released among our men. The result we knew. There was great indignation at home, because this act was clearly and blatantly at variance with the terms of the Hague Convention, but in France among our men there was even greater anger. Emergency respirators of a kind were rapidly improvised, but many thousands of our men were killed by the gas, and many of the survivors suffered most terrible agonies. These first respirators were merely pads of material tied round the mouth, not unlike what a Dickensian character might wear if he were suffering from a sore throat or a badly stopped tooth on a cold day. They were more effective when moistened, but they were not a striking success.

We ourselves began to use gas in September 1915. It was a great secret, and it was so well kept that the first intimation many of us had of our intention to use gas came from those at home who were serving their country by making it. About this time many artillery units found themselves digging numerous small dug-outs in the front line, just sufficiently large to accommodate " a general and one staff officer." Most units set to work without putting any but a literal interpretation on this somewhat extraordinary order. These dug-outs were for the accommodation of our cylinders of chlorine.

At the same time there appeared a new brand of brothers in the Corps of Royal Engineers. They were nicknamed the Coloured Corporals, partly because of the armlet of many colours which they wore, and partly because the lowest rank in the company was that of Corporal. These men were for the most part excellent chemists in private life, but in war their duty was to handle the heavy cylinders of chlorine (familiarly termed Roger), and to release the gas at the required moment. Many an infantryman or gunner, watching these men, felt glad that at school chemistry had not been in the curriculum.

But the use of cylinders of poison gas was open to many objections. The cylinders were not only very cumbersome, but they were extremely vulnerable. (They went off when struck by an enemy shell, even though they weren't manufactured for that purpose.) In addition the opportune discharge of gas depended on the slope of the country in front of the front line, and on the shape of the trenches and on the direction and velocity of the wind. Even then, after much palaver over the 'phone, and the alteration of the zero hour because of "conditions," the discharged gas not infrequently did some harm to our own troops as they went over to the attack.

In consequence shells, trench-mortar bombs, and even hand grenades were filled with poison, and then fired into the enemy's midst. These had no back effect, and so long as they fell approximately at the chosen spot they were effective.

For success in attacking by gas, one of the most important things was to maintain a high concentration of the poison in the air around. One part of a gas in a thousand of air when maintained was considered a high concentration, and indeed one part in ten thousand with most poison gases was quite effective. One would imagine that the denser the gas the more deadly it would be, other things being equal, because it would lie in trenches and in shell-holes where soldiers were; but it must be remembered that all poison gases soon became very diluted by the air round, and the density of the mixture therefore, after a time, could not be very different from that of air itself.

What did the scientific organiser of gas warfare consider to be the most important features of a gas? First of all, the ease with which the necessary large quantities of the gas could be made, and the convenience with which it could be transported; secondly, the effect of the gas when inhaled by the soldier, and the difficulty the other side might have in providing adequate protection against it.

The best known of the gases used were chlorine, phosgene, mustard gas, and chloropicrin, but many more, described by long chemical formulæ and even longer chemical names, were used by both sides. The element of surprise was an important tactical point, and it was considered clever to send over a new gas of which the other side was ignorant, and against which they had provided their soldiers with no protection.

Chlorine, as everyone knows who has inhaled it, even in small doses, has a most irritating effect on the throat and lungs. It is, however, a simple and honest poison. You may see it coming, and so avoid it. Further, either you get it or you don't get it. With phosgene, on the other hand, you are never quite sure where you are. Although its effect is less irritating than chlorine, it has a delayed physiological action.

[*Continued on p. 60*

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It may be breathed apparently with impunity, but the trouble comes later.

Chloropicrin was one of the chief lachrymators or weeping gases, and was used effectively, even at a concentration of one part in a million, against troops doing any work in which weeping rather interfered with things. Mustard gas was an irritant which even in very small amounts had a very inflammatory effect on the skin, the more insidious because it was not immediate. It produced serious sores at the parts affected, notably on the eyes, leading to many cases of permanent blindness, and to an enormous number of cases of temporary blindness.

These are the best known, but more irritating and more deadly gases were being experimented with towards the end of hostilities. It is rather curious that prussic acid, which is associated in most minds with sudden death, was used so little. The reason for this is that, except in large concentration, its effect is very mild. Also it is a very simple gas to secure protection from with a respirator.

The first respirator issued to our troops after the original mouth-pad had been superseded, consisted of a flannel helmet with mica eyepieces, which was pulled over the head and tucked in under the collar. Impregnated in the flannel was a solution of "hypo" and other materials for absorbing the chlorine. Later patterns of this type were provided with glass windows for the eyes, and a rubber valve for exhaling the breathed air. After a time a box respirator was introduced, and this completely superseded the helmet type. This respirator consisted of a small box filled with granules of specially prepared charcoal, which was guaranteed to absorb nearly every kind of poison gas known. It was connected with the piece that covered the face by a flexible rubber tube. A clip gripped the nose in a most convincing manner. The breathing in and out was done through the mouth by means of suitable valves.

It was a simple device, comfortable enough, and everyone who was in France had the pleasure of drilling in it. It gave complete protection against most of the poison gases used, and when the charcoal deteriorated it could be easily replaced.

It is the opinion of a speaker at the last meeting of the British Association that poison-gas warfare is not so inhuman as it is commonly supposed to be. The argument was, that granted that human beings must die or suffer so that military objects may be gained, then such objects may be attained by the use of poison gas with less loss of life and permanent injury than by the employment of high explosives.

We agree, but we hope that this type of warfare is ended for ever.

A. S. Russell.

Correspondence

METEORIC SHOWERS AND COMETS

To the Editor of Discovery

Sir,

Though the practical identity of certain meteoric systems with comets has been an acknowledged fact for more than half a century, there are not more than six instances which may be said to have been demonstrated fully. This meagre result is due to several causes, the chief of which are that (1) comparatively few comets revolve in orbits which intersect the earth's path or pass sufficiently near it to occasion a shower of meteors; and that (2) observational data are scanty, for students in this branch of astronomy have rarely applied themselves to the special purpose of discovering new instances of meteoric and cometic identities. Yet if more attention were directed to this part of the subject, there is no question that our knowledge might be considerably extended.

There are doubtless many cases where meteor and cometary orbits exhibit mere chance agreements, but were the observations more abundant and accurate, it would be possible to select those entitled to confidence as representing true accordances. It is to be hoped that this department will receive more earnest attention in future years.

On October 22 of last year a fireball was seen at Bristol and at other places by various good observers. It had a long horizontal course of about 335 miles from the North of England to the South of France. Its radiant point was at 156°+39°. Now the comet of 1739 has a radiant point at 157°+39° on October 22 according to computations made by the late Prof. A. S. Herschel. Here is a possible case of a meteoric fragment from a cometary system. The writer has seen, in and since 1877, other meteors from the same source, and it seems a fair inference that these objects owed their derivation to the comet named. In some cases no doubt the visible meteor showers allied with comets may be extremely feeble, and incapable of furnishing exhibitions of the brilliant and abundant character of the Perseids of August and Leonids of November, but they are none the less interesting, and deserve fuller investigation.

W. F. Denning, F.R.A.S.

Bristol,
January 16, 1920.

Reviews of Books

Outlines of the History of Botany. By R. J. Harvey-Gibson. (Black, 10*s.* net.)

Professor Harvey-Gibson has given us the substance of a course of lectures which he delivered to his students in the University of Liverpool. It is an account and a discussion of the more important features in the advances of botanical knowledge from the earliest times down to the present day. Now this is the kind of book we like. It gives us an interest in a subject without our having to pass an examination prior to our imbibing the facts. On us a textbook has a stand-and-deliver effect, but a history is always genial and kindly. It admits us to the subject at once. There is no waiting in a queue or fumbling for cash at the door. We go right in—"on the nod," it is true—but we get in, and no unpleasant questions are asked.

The general reader has more leisure for the study of the history of a subject than the ordinary University student. The latter is compelled by his examiners to pursue the policy so warmly advocated by Mr. Gradgrind, and go in for Facts, and consequently, in a present-day University curriculum there is little room for the pleasant occupation of studying the history of a scientific subject.

Professor Harvey-Gibson, in this excellent book of his, points out, however, that a proper estimate of the relative values of the results achieved by investigators in the past, leads to a picture, in correct perspective in the mind of the reader, of the evolution of the science as a whole. It is an antidote to narrowness of view and to premature specialisation. There are some people who dislike History just as there are some Scots who dislike England. They do not see the point in getting to know what Linnæus (for example) thought of such-and-such a subject in the year 1686. To them it is as irrelevant as the old pantomime gag, "What did Mister Gladstone say in '74?" Besides, you only get five marks for the history question in the examination!

But this is a wrong view. In the history of any subject there are always two interests: an interest in the subject-matter itself, and a more human interest in the men who overcame the difficulties in developing their subject. One may be interested in Botany without caring a fig for a fig-tree, but the point not to be overlooked is, that this interest may lead to a deeper one. And so it comes to this: Does the history tend to make one long to study the subject more, and join in the work of development oneself, provided the necessary ability is capable of being produced? If the history of a subject were the record of an infallible past, it would never stimulate the worker to be up and doing. He would be in the same plight as the research-worker who complained bitterly that all the obvious things in his subject had long ago been discovered. But such history, if it be properly written, reveals not only success and wonderful achievement, but also failure, error, and even crass stupidity. And it is because of this that we, duffers, and yet at the same time remarkably fine fellows, believing ourselves akin to the great men of the past, are constrained to take heart and carry on the work which their genius initiated.

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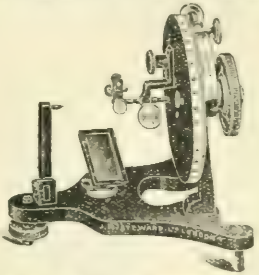

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Editorial Notes

The reception which the reading public has given our first two numbers has been a very good one, and is encouraging to all those of us who wish the journal to take the place among periodicals which we hope it should occupy. To those readers who have sent us helpful advice and criticism we are very much indebted, and as soon as possible, we feel we should like to put all their good suggestions into practice.

* * * * *

Murmurs of dissent, fortunately enough, have been almost entirely absent, but there is nevertheless one point that has worried several of our correspondents which it may be well to clear up. It is suggested that we were indiscreet in describing, in the first number, operations of offensive and defensive warfare which might conceivably be used by such enemies as we may possess "in the next war." It is a good point, and it needs an answer. The answer is that no secrets or facts of the slightest tactical importance were disclosed in either of the two articles cited. The actual dry facts on which both articles were based have long ago been made public. They are well-known facts in chemistry and physics, the knowledge of which is common property. It is true, of course, that there are many secret processes and "stunts" about which the less said the better. It should be realised, however, that many of these real secrets were communicated to our Allies during the war, so that their co-operation with us might be more effective. These Allies, then, know more of our own secrets than do our general public, so that, if any of our late Allies should be enemies "in the next war," the secrets are out and the mischief is done.

* * * * *

An important book[1] dealing with the relation of discoveries to general life has been recently published, and deserves general attention. Professor Soddy deals with the effects of discoveries, particularly in natural science, upon national greatness and prosperity, upon peace and war, on education and University ideals, and on human belief. Part of the book is controversial in character, and all the conclusions reached will not command universal acceptance; but the sincerity and vigour with which the author puts forward the need for discoveries, and for the better recognition and treatment by the commonwealth of those who make them, is the important thing about the book.

* * * * *

The main argument of the book is this: At the bottom of all our material development is our knowledge and control of the inanimate world. This knowledge and this control, however it may be distorted or exploited by men for selfish ends, depends ultimately for its existence on the investigator working in his laboratory. This man works away quietly and patiently, sometimes at great financial sacrifice to himself and often with little public recognition, for the pure love of truth, and the desire to extend the horizons of our knowledge. Men with such ideals, and with the necessary brains and energy, when helped by material resources, are the men who make discoveries. Most of these investigations may seem unimportant at the time, but eventually the importance of some of them is realised, and some new process in industry, or cure in medicine, or instrument in surgery, or help in the ordinary routine of life, results. These men are treasures. They should receive more recognition and help than they do. Nothing is too good for them. Scientific work cannot be done in a garret by the light of a candle. It needs apparatus and money. Money must therefore be forthcoming if research work in pure science is to continue, and, if it be forthcoming, whether from the Government or privately from men of wealth, it should be devoted to the cause for which it was given, and not diverted into other channels, as Professor Soddy argues so much of it has been in the past.

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[1] *Science and Life*, by Frederick Soddy, M.A., F.R.S. (John Murray, 10*s*. 6*d*. net.)

* * * * *

Einstein's theory of relativity has come to stay, so, however complex and incoherent it may appear to us at present, we must, we suppose, try to grasp what it is all about. In recent numbers of *Nature* this subject has been dealt with by many writers and correspondents, and certainly it has been made more understandable than it was in the original accounts. A good description of the theory was given by Professor Lindemann of Oxford in a recent number of the *Times Educational Supplement*. An English translation of the book by Professor Einstein himself is announced for the spring.

* * * * *

Professor Pear's article in the first number on the Psychology of Dreams has aroused great interest. We have decided, therefore, to deal from time to time with other branches of psychology. This is now an experimental science which, although it is of comparatively recent date, is already of great importance, and also of great human interest. Its main foundations are well and truly laid, and it appears to have a very promising future. During the war psychology was brought into great prominence, because of the extraordinarily good work done by its workers in the treatment of nervous disorders in soldiers resulting from the war.

* * * * *

We wonder if it is realised, as it ought to be, how much good original poetry and prose in our own language is being written at the present time. With peace has come a large output of imaginative writing, the best of which should not be passed over or left unread until the critics of the next generation tell those of us who are then alive what great fellows contemporary writers are. The best of the literary weeklies and monthlies are very much alive, and for those who have not time to wade through everything that is published, but time only to read what is worth while, they act as very helpful and pleasant guides. To discover the best writers of to-day, and to rediscover the best of the literature of the past, that surely is a good piece of work we can set ourselves to do.

Lapsed Memories

By P. B. Ballard, M.A., D.Lit.

Inspector of Schools, London County Council

WITHIN the last decade psychological interest has been transferred from remembering to forgetting. The psychologist is now less concerned in explaining how we remember than in guessing how we forget; and especially in guessing what it is we have forgotten. For it is now a well-established theory that forgetting —or, rather, a certain kind of forgetting—is the cause of serious nervous disorders, such as hysteria, and certain forms of incipient insanity. The proof lies in the fact that when the patient ceases to forget he ceases to suffer: with restored memory comes restored health. This simple truth came into marked prominence during the war. Shell-shock, with its distressing symptoms, is as a rule traceable to forgetfulness. The sufferer cannot, for all his efforts, recall what happened in those moments of peril and terror that broke down his nerve; nor, indeed, the events that immediately followed. And when, under hypnotic treatment, or by that more tedious but more efficacious mode of probing the mind known as psycho-analysis, he is enabled to retrieve his lapsed memories, the symptoms nearly always disappear—often with surprising suddenness. When they still persist, in large measure or small, it is generally found that the root of the trouble lies still further down, in some earlier forgetfulness that had already weakened the resistance of his nerves.

Here we have a kind of forgetting which brings suffering in its train, and demands, in the interests of human happiness, a careful study. It is clear that, as a rule, forgetting is a perfectly harmless process; nay, even necessary and beneficent. To rid the mind of lumber is a wholesome thing to do; and to rid it of learning does no great harm. There is no reason to think that those of us who have forgotten some of the things we learnt at school are, from the point of view of health, any the worse for our forgetting; it is certain that efficient thinking depends on a judicious forgetting—on a leaving out of the unimportant and the irrelevant. Physiologically speaking, memory depends on a modification of the nervous system: every experience leaves a trace there, and that trace is the basis and guarantee of its recall. But as time passes since their last revival these traces gradually fade away, and the memories they underlie get more and more difficult to call back to consciousness. Many of them, indeed most of them, never come back at all. That is the normal and healthy process of obliviscence—a gradual passing of our experiences into oblivion—a process mainly dependent on the time that lapses since they were part of the actual thinking mind. The deeper impressions will take longer to fade away than the fainter; but fading is the inevitable fate of them all.

How, on this basis, can we explain the forgetfulness that leads to shell-shock? Why should the victim forget an experience which must have made a profound impression upon him? To all appearances it seems just the sort of experience that a person would be least likely to forget. To explain this obliteration of so moving, so disturbing a memory, we must postulate another kind of forgetting which differs totally from obliviscence. Obliviscence attacks the weak; this the strong. Deep emotion hinders one and favours the other. Obliviscence acts gradually, and gently carries the experience over the line that separates the recoverable from the irrecoverable; this other forgetting suddenly and violently pushes the experience beyond the limit of recall. In one case there is a slow and steady sinking into the unconscious, in the other a sudden fall.

This latter type of forgetting has by the new school of psychologists, the psycho-analysts, been termed "repression"; and the resulting forgetfulness has for many years been known as amnesia. Is repression a normal process or is it pathological? Is it a healthy or harmless thing that, like obliviscence, happens to everybody, or is it a malady that happens to few? Dr. W. H. R. Rivers favours the former theory.[1] He maintains that repression has a definite biological value. There is probably in the mind of man a machinery of repression which works on the whole for his benefit and comfort; there is certainly some such machinery in the mind of the lower animals. The frog, for instance. In the early stages of its life it is a fish, a tadpole. It inherits fish-like instincts and acquires fish-like habits. It breathes with gills, has a very serviceable tail, and useless rudimentary legs. But when it becomes a frog it gives up fish-like things. It lives on land, breathes with lungs, has very serviceable legs, and a useless vestigial tail. To forget the experiences and habits of tadpoledom, and to acquire a new set of habits and customs, is the whole duty of frogdom. But simple obliviscence is far too slow a process to help him within the necessary time. For of all memories, motor memories, when organically fixed, seem the most difficult to forget. The swimmer, after long years of abstinence from the water, swims as readily as if there had been no intermission at all. In fact, repression must have been at work. The frog forgets his infancy, the full-grown insect forgets the metamorphoses through which it has passed.

This survival value of repression in the lower animals suggests the function of repression in the human mind. It may be useful in the preservation of life; or, on the other hand, it may be the vestige of a process once useful, but now indifferent or even harmful. By dealing with the concrete facts, and quite independently of such biological speculations as I have outlined, the psycho-analysts have arrived at the conclusion that repressed material is always unpleasant. The motive for repression is one's personal comfort. One represses to preserve one's peace of mind. This is obviously so in the case of shell-shock; it is demonstrably so in the case of hysteria; it is probably so in other and less harmful forms of repression. The shell-shocked soldier had to face terrors that were more than he could bear; be became unconscious and forgot; a beneficent Nature threw over his mind a pall which, although it ultimately did him harm, preserved him at the time from a still greater harm—death from shock.

The curious amnesias of hysteria I have no space to discuss: I must content myself with an illustration from one of the common occurrences of everyday life—the forgetting of proper names. Why are people's names so hard to remember as compared with other words? Why does one particular name sometimes slip out of the mind and defy all efforts at recall? The most plausible explanation seems to be that we think of a friend in pictorial terms. We catch in imagination a fleeting glimpse of his face, or of some characteristic feature of dress or person, which serves as his symbol and saves us the trouble of recalling his name. I cannot in this way envisage an abstract relation: to think clearly of general and abstract things I must think in words. And thus it comes to pass that my friend's name, unless I have to speak it aloud, tends to fade away through sheer lack of repetition. Now mark how the psycho-analyst explains it. He holds that, when we are prone to forget a person's name, it is because we dislike him, or because there is somebody else of the same name whom we dislike; or because his name, or his dress, or his face, or his conduct is in some way, direct or devious, connected with some unpleasant experience of our own, and the censor (as Freud calls the repressing force), to make assurance doubly sure, not only represses the unpleasant experience itself, but also all the mental factors that are likely to bring that experience back to consciousness. It may be that we are unconscious of this connection (indeed, we generally are), but the connection is there, and if sufficient trouble be taken it can be brought to light. For a full defence of this position I must refer the reader to Dr. Ernest Jones's article on "The Theory of Repression in its Relation to Memory."[2] It must not be thought that these two theories, obliviscence and repression, are alternative theories, one of which must be accepted and the other rejected. The probability is that both theories are valid, and that neither in itself affords a complete explanation of the facts of forgetting.

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[1] *The British Journal of Psychology*, vol. ix, pp. 236-46.

[2] Ibid., vol. viii, pp. 33-47.

Having dealt broadly with forgetting, we must now consider the second part of our problem: How are these lapsed memories (the things we can't remember as distinct from those we merely don't at the moment remember) to be brought back to consciousness? How can Jekyll remember Hyde, and Hyde Jekyll?—for such cases of double personality are forms of amnesias not unknown to science. How can the forgotten name be again remembered? If simple obliviscence were the one universal law, then all mental impressions would gradually fade away until they got beyond the limit of recall, where they would for all practical purposes disappear. But obliviscence is at least partially counteracted by an opposing tendency towards what I have elsewhere called Reminiscence [1]—a re-remembering of the forgotten. We attend a concert and hear a catchy tune, but fail to recapture it next day. But ultimately it comes back to us of its own accord as it were, and we can sing it without hesitation and without doubt. This is reminiscence. Again, we try to recollect the name of an acquaintance, but fail and give it up. In an hour or so, when we are thinking about something else, the name we want leaps unexpectedly into the mind. This, again, is reminiscence, a process common enough among adults, but commoner still among children. If a class of children be given a limited time to learn by heart a piece of poetry, it is found, by testing them, that on the whole they remember more two days after they have learnt it than they do immediately after learning it. Lines that had eluded them at first come back to them at last. As a final example of reminiscence, I will suggest a significant experiment which the reader may make upon himself. Let him select a clearly defined part of his past life, such as a holiday he has spent abroad, and let him jot down all the events of that period that he can remember. If he then dismisses the matter from his mind, and after a day or two tries to add to his notes, he will find that many of the things which he had failed to recall on the first occasion are now clearly remembered. And after further periods of rest he will find himself remembering more and more. And the same thing will happen if, instead of a period of his own life, he selects a period of history which he studied years ago, or a poem which he once memorised, or a branch of science that he once mastered.

He will, in any case, realise the important fact that, when one memory is called up from the depths of the unconscious, it tends to bring up other memories with it; when one idea recrosses the border-line that separates the recoverable from the irrecoverable, it tends to pull across the border other ideas associated with it; and, given sufficient time, these other ideas will one by one come across. To start this crossing of the border we must, of course, begin with ideas that lie on the conscious side of the line. These experiments force us to the conviction that the association links that bind our experiences together still exist after the experiences themselves have sunk into the unconscious. This is the basal fact upon which the psycho-analysts rely in their quest for that group of lost memories which they call a "complex," and which they believe to be the source of some neural and mental disturbance. There is some difficulty in finding a suitable starting-point; but as Professor Pear pointed out in the January number of this journal, the patient's dreams supply a clue to the track that leads to the hidden complex.

Sir William Hamilton, many years ago, remarked that it was probable that all our memories were preserved, and that it was forgetting, and not remembering, that called for explanation. And the view was regarded as fantastic and quite unsupported by fact. But in this, as in other things, the heterodoxy of yesterday is fast becoming the orthodoxy of to-day. For the number of amnesias that have been cured, the number of experiences, minute and detailed, that have been gradually brought back from the limbo of the past, the number of memories that have in certain abnormal states been reproduced with almost phonographic faithfulness, have led modern psychologists to suspect that nothing that has ever been experienced is really lost. Nay, it need not even be experienced. Things seen or heard, but not noticed, like the multitudinous pictures that fall upon the margin of the retina, have been faithfully described by patients during an hypnotic trance.

I have but touched the fringe of a tremendous subject, a subject full of undreamed-of possibilities and teeming with unsolved problems. I have not touched upon the theory of different levels and layers of consciousness; nor upon the way in which a complex sometimes grows until it seems to form a separate self which may gain the ascendancy over the normal self, and give rise to alternating personalities, as though two souls occupied the same body.

And the facts revealed give abundant scope for metaphysical speculation. In this I will not indulge, but merely remark that the term "integrity," as applied to a man's character, takes on a fresh meaning; and that new light is perhaps thrown on the line from Wordsworth's ode: "Our birth is but a sleep and a forgetting."

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[1] "Obliviscence and Reminiscence," *The British Journal of Psychology*. Monograph Supplement, No. 2.

The Biological Problem of Cancer

By J. A. Murray, M.D.

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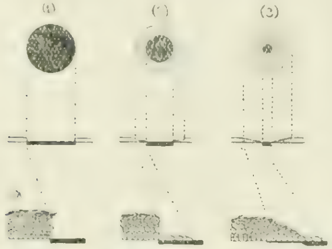
HE problem of the nature and causation of Cancer one of perennial and baffling interest. The disease is existed from the earliest times, and to-day still kes a heavy toll of humanity. Its ravages are not nfined to mankind ; domesticated and wild animals, rds and fishes, all are subject to it in varying degree. all it presents the characters of a cellular local vergrowth of some part of the body, growing pro- essively till it destroys life. A mountain of paper is been covered with descriptions of the details of e structure of cancer, its naked-eye appearances, e course of the disease, and numerical tables of its equency in successive years in all countries. It ould be futile to attempt a summary even of the lient facts embodied in all this recorded experience ithin the limits of the present essay, which must be stricted to a statement of the central problem, the rnel of cancer research, as it appears to the writer.

As a preliminary, some elementary facts of the struc- re and life-history of living things must be touched on. Underlying the diversity of appearance and mplexity of the bodies of the higher animals (to ich it is convenient to restrict ourselves), there is surprising uniformity of structure. Skin, bone, ood, brain, liver, and intestines, all are made up of cells," microscopic in size, differing in detail, but built on the same plan. In the warm-blooded imals like ourselves their size is such that, placed end end, from 1,000 to 3,000 will lie in the space of an inch. ey are of a semi-fluid or watery consistence, and in ch there lies a denser spherical body, the nucleus. e surrounding clear substance is termed protoplasm, d with the nucleus is the repository of the processes life. Masses of cells of the same kind are called sues—e.g. nerve tissue, epithelial tissue (covering e surface of the body and lining the intestines), iscular tissue, and so forth. The organs of the body, ch as the brain, the heart, the liver, are made up of number of tissues modified and arranged for the rk they have to do. Careful measurements have en made of the cells of corresponding tissues from nts and dwarfs, and their sizes have been found to the same. The difference in size of the individuals question is therefore due to the greater number of lls in the body of the giant. The same holds good the tissues of children and adults : their cells e of nearly the same size, but there are more of them in the adult. Similarly the corresponding cells of a rat and a horse are nearly of the same size, and they are correspondingly more numerous in the larger animal.

How is this uniform size of the cells maintained while their number increases ? In the simplest manner imaginable. If we examine the cells of the liver of a new-born mouse, we find that in a considerable number the central spherical nucleus has divided into two, and then a constriction appears in the surrounding protoplasm. The constriction gradually deepens till the cell is cut quite through, and two cells, each half as large as the original, result. In a growing animal the two daughter cells produced in this way rapidly increase in size, till they are as large as their predecessor, when the process is repeated. This alternation of division of cells, and increase of the daughter cells to the previous size, is the universal mode of growth in the higher animals. As everyone knows, the process is more rapid in the young. A child which weighs seven pounds at birth may be three times as heavy at the end of the first year of life. As age advances the process slows down, and a time arrives when the size becomes constant, and we say that growth has ceased. Careful and minute study of the cells of adult men and animals shows, however, that cell-division is still going on in many of them. This is usually regarded as a provision for replacing cells worn out or damaged in the business of life. From another standpoint it may be regarded as a slower continuation of the growing process which is so obvious in early life. In extreme old age it becomes still slower, and is no longer adequate to keep up the size of the body. The very old seem to shrink in bulk and stature, and when the failure reaches some organ essential to life, such as the muscular tissue of the heart, life sinks to its final ebb.

Two remarkable properties of the living body lessen the similarity which this sketch conveys of machine-like regularity, as of a watch wound up and allowed to run down. The individual cells of the various tissues are not independent, self-contained units, each going its own way. They are subject to a general controlling influence, the nature of which is still obscure, which limits their rate and amount of growth, so that a fairly uniform proportion is maintained between the different organs and parts of the body. The reality of this regulating mechanism is also shown by the fact that the different animal species (and even the smaller racial groups), each attain a characteristic average size. The rat, the lion, the terrier, and the mastiff, will occur to everyone. In the same way sheeps' hearts or kidneys are always pretty much of a size, and smaller than the corresponding parts of the ox. We shall see that a failure of this controlling influence is closely related to the origin and growth of cancer.

The second peculiarity of living things is one which is of the greatest importance to the well-being, and in fact the existence, of man and animals. It is within the experience of everyone that the tiny patch of skin which is knocked off by accidental contact with a sharp table corner is quickly replaced. As soon as bleeding stops, either by the application of pressure or, as we say, of itself, a red glazed surface forms. The edges of the little wound, which were at first irregular and steep, become shelving, and the opaque white surrounding healthy skin thins off to a translucent bluish edge. This creeps in over the red, raw surface from every side till the whole defect is repaired. It is worth while to go into the details of the process, so far as the outer layer of the skin is concerned, with the aid of the accompanying diagrams. Let the three black circles 1, 2, 3, represent the raw surface as soon as bleeding has stopped (1), next day (2), and on the day after (3), when healing is nearly complete. Below, on the same scale, are the appearances that would be seen if the wound were cut across and viewed from the cut surface—that is, in section. The third row of figures shows the appearances seen when a thin slice from this cut surface, suitably prepared, is examined under the microscope. The outer layer of the skin consists of several layers of cells, the outermost of which are flattened, dried, and horny. These are dead and are being constantly rubbed off, insensibly for the most part, in visible shreds when a Turkish bath is taken. They are replaced by division and growth of the cells of the deepest layer, which look like a row of bricks stood on end. This basement layer is the only one capable of cell-division, and alone takes part in the process of repair. The cell of this layer next the defect divides into two, and the new cell next the raw surface is pushed out over it. Still retaining contact with its parent, it flattens out and itself divides. The mother-cell divides again, and the process goes on till a considerable part of the edge of the wound is covered by a single layer of flattened growing cells. Those nearest the undamaged skin soon acquire the elongated form of the deepest layer (3), and when they divide, one of the daughter cells is pushed upwards and repeats the appearances first described. The new skin thus increases in thickness till the outer surface is flush with its surroundings. When this stage is reached, the rate of cell-division slows down again to the original speed.



Diagrams to illustrate the healing of a small wound of the skin. The three black circles in the upper row represent the raw surface uncovered by skin, as seen from the surface. The second row shows the wound, on the same scale, as if cut across and viewed from the cut surface. The third row shows the appearances of the margins in the second row, more highly magnified to show the single cells. Dotted lines join the corresponding parts of the three sets of figures.

The important points for us to notice in this process are, first, that the cells of the skin can be wakened up from the ordinary rate of reproduction and excited to more rapid division and growth by removal of some of their neighbours; and, second, that when the gap has been mended, the temporary spurt is checked, and the cells return to their regular workaday jogtrot. It is very probable that reciprocal influences of cells of the same kind on each other are in part responsible for this opportune halt. A complete explanation, which does not attribute semi-intelligent action to the cells, is yet to seek. It has an unmistakable resemblance, however, to the regulating power, already mentioned, which maintains the just proportion of the different parts of the body. Repair processes, essentially of the same kind, take place in the deeper parts of the skin after such a slight wound as has been described. In other organs, also, destruction and damage are followed by a similar response.

The description of the various agents which cause damage to the tissues, and the peculiarities of the alterations they produce, is the province of the science of pathology. It will be sufficient to draw attention to a few examples of agencies which produce rather less obvious forms of damage than the simple abrasion just described. Workers in paraffin-oil refineries, after long-continued action of the oil on the hands and arms, frequently suffer from a slow inflammatory condition of the skin. When the irritated condition of the skin has persisted for some time, numbers of warts make their appearance. Warts are circumscribed overgrowths of the covering layer of the skin. We may assume, either that some kind of damage to the cells of the skin releases them from the regulating power which restricts their rate of multiplication, or that substances in the oil excite the cells to division in spite of the restraining influence. The majority of such warts after attaining a certain size cease to grow. If the special irritant which caused them be removed, they usually diminish in size and may disappear. If the irritation be continued, however, further changes take place in some of them indicating a profound alteration in character. Instead of remaining stationary in size, they begin to grow slowly. Bleeding occurs with or without injury, and the dried blood forms a black, hard incrustation or scab. When this is removed, a raw ulcerated surface is exposed. The margins of the ulcer are thickened and hard. On microscopic examination the thickening is seen to be due to multiplication of the cells of the outer layer of the skin. Instead of covering in the defect in the surface as described for the healing of a small abrasion, the cell masses are arranged irregularly, and break down nearly as soon as they are formed. In this way the ulcer continues to spread, always surrounded by a wall of irregularly built up skin. If nothing be done to arrest its course, severe blood-poisoning sets in, due to the entrance of bacteria into the blood-stream, or a large blood-vessel is involved by the friable newly-formed epithelial cell-masses and death results from hæmorrhage.

Such a progressive cellular overgrowth is described as cancerous, and the description given for cancer of the skin applies, with slight modification, to cancerous ulceration of the lip, tongue, stomach, and intestines. In parts remote from the body surfaces growth extends in all directions fairly equally, and the newly-formed cells, even if they break down, are not removed, so that the resulting mass is approximately spherical. Varying resistance of the parts encountered by the growth in its progress causes departure from the simple geometrical form. The one constant character common to all is the continuous new formation of cells going on till death results.

It will have been noted that emphasis was laid on the long duration of the irritation which precedes the definitely cancerous stage in the evolution of the skin warts produced by paraffin. This is a very common feature in the antecedent history of cancer in many parts of the body. As is only natural, this is especially noticeable in cancers on the surface of the body, since the ease of observation permits us to recognise slight degrees of damage which might not reveal their presence in the deeper parts. Long-continued or chronic irritation, then, is a very frequent precursor of cancer, and this necessity for a considerable lapse of time for chronic irritation to end in cancer is probably one of the main reasons for its predilection for later life in man and animals. The kinds of irritation may be very varied, provided they are not too severe and last a long time. They may be chemical, as we have seen in paraffin cancer and pitch warts, or soot which produces the very fatal chimney-sweep's cancer. Radiant energy is responsible for cancer of the shins of railway-engine drivers, for cancer of the chest opposite the opening of the burnous of the Soudanese, or X-rays for cancer on the hands of X-ray operators. The irritation of animal parasites has been followed by cancer of the tongue and stomach of rats (Spiroptera cancer), and of the urinary bladder in the human subject (Bilharzia cancer), and so on. From this great variety it can be seen that measures for the prevention of cancer cannot be divorced from those needful for the general improvement of the conditions of life. In accordance with this, Dr. Dublin has found a greater liability to cancer in American wage-earners than in those in easier social circumstances, and Dr. Stevenson has shown that the maximum number of deaths from cancer in public institutions in this country tends to occur at ages definitely lower than in the general population.

Keeping in mind the facts that cancer begins in a circumscribed area and increases in size by a continuous multiplication of cells, the crux of the problem presented by it is seen to be: How are the cells in the localised area concerned, started on their altered tempo of growth, and why are they unaffected by the restraining influence which normally holds the cells of the rest of the body within their proper bounds? It would be very natural to assume that a weakening of the restraint which the cells of the body exert on each other is merely a part of the general weakening of the natural forces accompanying old age, in which, as already noted, cancer is progressively more likely to develop. A special circumstance has enabled us to eliminate this possibility, rendered unlikely by the fact of the circumscribed origin of these growths and the rarity with which they attack more than one tissue in the same individual. The circumstance alluded to is the occurrence in certain animals of cancerous growths which can be grafted successfully into normal animals of the same species. Most of this work has been done with mice and rats. A careful day-to-day study of the site of inoculation shows that there is no question of the cells of the inoculated animal's body becoming cancerous. What happens is that the cells introduced continue to grow until they form large masses of cells. The process can be repeated indefinitely in a succession of mice. It is not even advantageous to select old animals. Grafting succeeds better in young ones. Clearly, then, the rapid and continuous growth of cancer cells cannot be due solely to the weakening of the restraining influence on growth in the body of the cancerous subject. On reflection, there seems to be no escape from the conclusion that the cancer cells behave as they do because they are different from their neighbours. They have undergone a change in becoming cancerous, by which they no longer respond to the influences which restrain and regulate cell-division and growth in the body. Whether this change is a real increase in the energy with which the cells take in food and grow, so that the restraining influence is powerless to hold them in check, or whether it is a loss of sensitiveness to restraint, cannot be said with certainty at present. Although some cancers can be seen to increase in size from day to day, others progress so slowly that it may take months to be certain of any change, and the latter are no less fatal. The problem is subtle and alluring, and it is doubtful if it can be yet stated in a form suitable for direct attack. Until progress has been made, the causation and origin of cancer can only be partially comprehended, for we simply do not know what it is that arises, or is caused.

Another possibility, which has exerted a considerable influence on the course of cancer research, is that the cancerous change is due to the entrance of a microbe, with peculiar properties, into the cells prepared for its reception by chronic damage. Dr. Peyton Rous, of New York, has discovered that certain tumours of the domestic fowl can be transmitted to other fowls without transferring the intact tumour cells. These growths are indistinguishable, in structure and in the course of the disease, from true cancers. The agent responsible is almost certainly a microbe, so small that it lies below the limit of microscopic vision. These observations of Rous have been hailed as indicating the direction in which to look for the explanation of all cancers, but even the most enthusiastic supporters of this point of view will admit that it is still unproved, except for three or four cancer-like growths of the domestic fowl. Experiments to test this explanation on the tumours of mice and rats and of man have failed completely.

One of the great disadvantages which retards progress in the study of cancer is the absence of a means of producing the disease at will in experimental animals. Although, as has been already mentioned, we can carry over cancer cells from an animal in which it has arisen to healthy animals, and produce in them all the symptoms of the disease as it occurs naturally, it is not yet possible to induce the cancerous transformation at will in the cells of normal animals within a reasonable time. Prolonged exposure of rats to X-rays has in a few instances been followed by cancer, and experiments are at the present time being carried out in different countries with pitch and tar to try and produce the form of cancer which follows chronic irritation with these substances. It may be asked whether all individuals are equally liable to develop cancer under chronic irritation. The differences which have been observed in the parts of the body most frequently attacked by cancer in the different animal species and races of men, are sufficiently definite to make this unlikely. Even such closely related animals as rats and mice suffer from cancer in very different organs. Breeding experiments with mice have been carried out on a large scale here and in America, and have shown that it is possible to obtain stocks which differ enormously in their liability to develop cancer. The excessive liability which some of these stocks show can be transmitted to their offspring. It is therefore probable that hereditary predisposition may play a part in human cancer also, but, as is obvious, such intensive selective mating as has been carried out in mice is unlikely to occur accidentally in man.

The conception presented in the preceding pages is that cancer involves a local disturbance of the delicately balanced mechanism which, running smoothly in the healthy body, maintains its component cells as a harmonious whole. Beyond stating that the disturbances must have taken place and been perpetuated in the cells, which by their continuous division make up the cancerous growth, little is known. Those engaged in the study of cancer are heartened in their work by the conviction that, soon or late, the human mind will penetrate and master the intricacy of these balanced forces, and therewith bring the growth of cancer under control.

BOOKS SUGGESTED FOR FURTHER READING

Tumours, Innocent and Malignant. J. Bland-Sutton.
The Pathology of Tumours. E. H. Kettle.
The Experimental Study of Cancer: A Review. W. H. Woglom.
Lectures on the Pathology of Cancer. C. Powell White.

The Stamp Act of 1765

II. What George Grenville Did—and What He Ought to Have Done

By C. H. K. Marten, M.A.

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In the last number of this Journal the conditions and circumstances preceding the fatal Stamp Act were discussed. The British Government, as the Colonies seemed unwilling or unable, owing to their different circumstances and jealousies, to combine for their own effective defence, had decided that it was necessary to keep a permanent force of 10,000 men in America for defence against the Indians, a most dangerous rising of whom had just been suppressed. But the question arose who was to pay for this army? The head of the British Government at this time was George Grenville. He belonged, perhaps, to the most important political family at that period in England.[1] All his four brothers were at one time or another in Parliament, and three of them were Privy Councillors. He himself and his son both became Prime Ministers, the father in 1763, the son in 1807. His brother-in-law, the great Pitt, with whom, however, he was not in 1765 in agreement, had just won the Seven Years' War for England; his nephew, the younger Pitt, aged only six in 1765, was to be Prime Minister before he was twenty-four, and to hold that office longer than any succeeding statesman. George Grenville himself was industrious and capable, with considerable knowledge both of Finance and of Law. But his overlong speeches bored both the King and the House of Commons; and it was unfortunate for Great Britain that he was extremely obstinate, and above all possessed no tact. "Able, narrow and laborious," are the epithets Lord Rosebery applies to him; "He had a scientific and unimaginative temperament," says Mr. G. L. Beer, the American historian, "with a distinctly legal turn of mind." Some of his contemporaries were more emphatic in their opinions: "I would rather," said George III after Grenville's resignation, "see the devil in my closet than George Grenville"; and Horace Walpole, the diarist, calls him "that mulish carthorse."[2]

Let us see how Grenville, with his unimaginative and legal turn of mind, tackled what was undeniably a difficult situation. To him, as well as to many others since his time, it did seem unfair that the Mother-country, with her debt doubled as the result of the Seven Years' War, and paying the whole expenses of the Navy, should be called upon, in addition, to pay the whole cost of an army designed exclusively for American defence. He accordingly, first of all, passed a Sugar Tax, the most important item of which was a heavy duty on molasses from non-English Colonies—molasses being necessary for the manufacture of rum in Boston. The tax was partly to protect the English West Indies producing molasses, and partly to produce a revenue; and is a good illustration, incidentally, of the difficulties of arranging, without inflicting hardships, colonial preferences within an empire.

But, though this Act was unpopular, it was the second of the two Acts of George Grenville round which the great controversy was to rage. This was the Stamp Act, ordering all bills, bonds, leases, newspapers, cards and dice, etc., to have stamps, the duties varying from a halfpenny to £10; they were like similar duties in England, only they were lighter than those paid in the Mother-country.

The Stamp Act has been fiercely attacked, and England has been, and is still, accused of injustice in regard to it. But it is only fair to Great Britain and to George Grenville to point out that there was a great deal to be said on Grenville's side. In the first place, his legal position was unassailable. Parliament had the undoubted right to legislate for the Colonies, and that included the right to make laws imposing taxes, whether they were levied at the ports or levied internally. No one denied that the Parliament could legislate about Colonial Commerce; and Imperial Defence, after all, was an equally important matter.

Moreover, quite apart from what was legal, it cannot be said that Grenville's position was really unreasonable. After all, the proceeds from the Sugar Tax and the Stamp Act were only expected to produce something between half and one-third of the cost of this army, the remainder being paid by the already over-burdened Mother-country, whose debt had doubled and expenditure increased threefold since the beginning of the Seven Years' War. Moreover, as Mr. Lecky points out, "Every farthing which it was intended to raise in America, it was intended also to spend there." Then, again, Grenville allowed a year to elapse before he passed the Act in order that the Colonies might think of an alternative. He called a meeting of the agents of the Colonies in London and said, "I am not set upon this tax; if you can tell me of a better I will adopt it." But the agents could not agree upon any other tax which the Colonies themselves might impose. And, though the Stamp Act met with plenty of critics later, the storm it would raise was not foreseen by other statesmen in England. The great Pitt was ill, otherwise he would have opposed it; but the Bill was carried after a languid debate in the House of Commons, and without division or discussion in the House of Lords. And, indeed, both the Colonial agents in England and politicians in America failed to gauge the strength of the opposition.[3]

What happened when the Stamp Act—the "fatal Black Act"—came into force in the Colonies, on

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[1] For a brilliant description of Grenville's family see *Chatham, His Early Life and Connections*, by Lord Rosebery (1910), pp. 130–41.

[2] Grenville's nickname at the period was "The Gentle Shepherd." For in a speech in 1763 he had attacked Pitt's extravagance in the Seven Years' War, and asked those Members who opposed one of his budget taxes to say *where* a new tax could be laid. "I say, sir, let them tell me where. I repeat it, sir, tell me where!" On which Pitt, who was one of the Opposition, hummed to the great delight of the House a then popular ditty, "Gentle Shepherd, tell me where!"

[3] Thus James Ingersoll, the agent of Connecticut, obtained, and Richard Henry Lea, a prominent politician in Virginia, applied for, posts in connection with the collection of the Stamp Duties; both had some difficulty in explaining away their conduct later.

November 1, 1765, is well known. The bells were tolled as for a funeral, the flags were put half-mast, and the shops were shut.[1] There was a general suspension of business with England, and a complete refusal on the part of anyone to use the stamps. The "Passive Resistance" movement was complete and triumphant. Most ominous of all, representatives from nine Colonies met to protest—the first common action ever initiated by the Colonies.

Why, it may be asked, if Grenville's position appears so reasonable, did the Stamp Act arouse such opposition? The answer is that the Colonists were Englishmen, and Englishmen brought up in the traditions and principles of English liberty. Theirs was the same cause as that of Hampden in the previous century. Ship Money, against which Hampden protested in 1637, was a tax instituted and used for the admirable purpose of guarding the seas, and incidentally produced the first three-decker, the *Sovereign of the Seas*. The Stamp Act of 1765 was instituted for the admirable purpose of guarding the American frontier against attacks such as those of Pontiac. Ship Money was probably, and the Stamp Act was certainly, legal; but the one tax in England and the other in America met with the fiercest opposition. But there is this difference between John Hampden and the American Colonists. John Hampden objected to the Ship Money because it was not voted by the English Parliament; the American Colonists objected to the Stamp Act because it was. It is quite a mistake to suppose, as it is stated in so many textbooks, that the American Colonists revolted because they were not represented in the British Parliament. This, in the words of Professor Pollard,[2] was "no more the origin of the American War of Independence than Edward III's claim to the French throne was of the Hundred Years' War."

As we have seen in the first article, the Colonists had acquired, during the previous half-century, virtually complete self-government. They had been allowed to develop themselves, not altogether without restraint, but in effect largely so; and the control of taxation by their own Assemblies had become almost a mania with them. Grenville, in trying to impose the Stamp Act through the British Parliament, was trying, though he did not realise it, to put back the hands of the clock. Or, to change the metaphor, he was like a parent trying to treat a boy of eighteen as if he were a boy of fourteen. The American Colonists had reached manhood—they could be treated as children no more, and they objected to the absolute sovereignty of the British Parliament, though perhaps willing to recognise the authority of the Crown. "Is there not something extremely fallacious," said the famous American, John Adams, in 1765, "in the commonplace image of the Mother-country and Children-colonies? Are we children of Great Britain any more than the cities of London, Exeter, or Bath? Are we not brethren and fellow-subjects with those in Britain?"

The opposition of the Colonies is one of which both Great Britain and the United States may well be proud. Professor McLaughlin, the distinguished American historian who lectured in England in the spring of 1918, has well expressed the point of view from which that opposition ought to be regarded from both sides of the Atlantic. "The American Revolution," he says, "is, on the whole, the chief jewel in the Imperial diadem of Britain; it was one of her greatest deeds. It was based on English-born philosophy; it was waged by Colonists who had developed in freedom. . . . None but English Colonies, as we have seen, could have made such a fight for independence. . . . No one but Englishmen established American independence, and this they did on the basis of English History."[3]

But, whilst we may be proud of the Colonies, let us be just to the Mother-country. In the first place, neither the British people nor their statesmen were anxious to assert or to exercise the right of taxing America.[4] In the second place, the Stamp Act, though passed in 1765, was repealed in 1766, and Pitt the foremost, and Burke the best informed, of English statesmen, made some of their greatest speeches in opposing American taxation.[5] In the third place, let us realise once more that Grenville was in a difficult position. It is easy enough to see that he did the wrong thing—but extremely difficult to see what was the right thing to do. The present writer has corresponded with English and American historians on this point, and has failed to elicit a completely satisfactory reply. No doubt Grenville might have let Great Britain bear, in addition to all her other burdens, the whole pecuniary burden of the new force—but was that quite fair to the Mother-country? Or, he might have left the Colonies to look after their own defence, and find out by adversity the necessity of union for this purpose—but such a course would have been contrary to British traditions of Empire, and might have led to great disasters for the Colonies. Or, again, he might have allowed American representatives in the British Parliament. An English diplomatist, at the beginning of the nineteenth century, was told by two successive American Presidents, Madison and Jefferson, that if this had been done the Stamp Act would not have been opposed; but, as a matter of fact, neither the Colonies nor the English, in 1765, wanted American representation in the British Parliament, and, in particular, Burke ridiculed the idea owing to the distance and the slowness of communications.

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[1] The more ardent of our Colonists settled to eat no more lamb, so as to have more wool for making their own clothes.

[2] See an admirable article on "No Taxation without Representation" in *History*, October 1918.

[3] See *America and Britain*, by Professor McLaughlin (1919).

[4] See *Project of a Commonwealth*, part i (1915).

[5] Sir George Trevelyan prefaces his *History of the American Revolution* with an account of the condition of Eton at that time, and seems to imply that Eton, the home of the ruling aristocracy, was partly responsible. As one who has spent the far greater part of his existence at Eton, the present writer cannot refrain from alluding to the fact that if Eton produced George Grenville, the author of the Stamp Act, and Lord North, the conductor of the American War, she also produced Lord Chatham, the greatest opponent of the Stamp Act, and Charles James Fox, the greatest opponent of the war.

Lastly, let it be remembered, in Grenville's favour, that the problem of Imperial Defence, which proved the grave of his reputation, has not, as a matter of fact, yet been solved. As Mr. G. L. Beer says, "Modern English statesmen have not solved the difficulty; they have merely cut the knot!" Great Britain has learnt wisdom from Grenville's failure. But she has learnt it by bearing virtually the whole burden of the naval defence of the Empire till such time as the Self-governing Dominions, and other portions of the British Commonwealth of Nations, voluntarily afford—as they are now beginning to do—the support that she needs more and more. George Grenville, by precipitancy, broke up the Empire; the South African War of 1879, and still more the Great War of 1914, showed that Great Britain will secure, as a result of her patience since his time, the support of other parts of her Empire to an increasing degree. In this sphere of statesmanship, the policy of "Wait and See" has at all events been successful.

George Grenville was, especially when judged by the history of later events, certainly wrong in 1765; but some of the criticisms that George Grenville and Great Britain incurred over the Stamp Act, at the hand of many of the older historians, were certainly not deserved.

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Kite Balloons and Their Work

By P. H. Sumner, A.M.I.N.A.

Late Staff-Captain, Air Ministry

THE modern kite balloon was designed by Captain (now Major) Caquot, a French engineer. This replaced the old German type called the Drachen. The original Caquot balloon did not entirely fulfil the hopes of the small band of balloon enthusiasts, and further improvements were necessary to ensure stability in high winds. Finally Captain Caquot solved the problem by fitting the peculiar large stabilisers, or tails, which give the balloon a conspicuous, almost an uncanny, look. The first Caquot balloon arrived in England at the end of 1915, and in the summer of 1916 the exact prototype of the present balloon made its appearance. In the fittings to the balloon, and in smaller details of construction, improvements have since been made; otherwise it is essentially the same to-day as then.

The spherical balloon used for military observations in the past was not suitable for use as a captive balloon in high winds. This was because it drifted very much, so that for a small increase in altitude a large amount of cable had to be paid out. An increase in our knowledge of dynamics as applied to the air has made it possible for many defects to be eliminated, so that the drift of a captive balloon in high winds causes a deviation from the vertical position of the cable of a few degrees only. At the same time a strong head-to-wind position may be maintained even in winds of eighty knots (92 miles per hour). Spherical balloons used to spin round and become unmanageable in winds as low as twenty knots.

The spherical balloon is now used in the Service for training airmen. All airship pilots and balloon observers are required to pass-out a course in free ballooning, which includes a night flight and a solo flight (i.e. the pilot is alone in the balloon). The smaller spherical balloons have a capacity of 25,000 cubic feet; the larger, which can carry seven persons, a capacity of about 80,000 cubic feet. They are generally filled with coal-gas. The kite balloon, like the airship, is, however, filled with hydrogen gas. The envelopes of the old spherical balloons and airships were made of gold-beaters' skin, but nowadays all envelopes are made of cotton fabric rubbered on the inside. The rubber makes the fabric gas-tight; it also prevents impurities in the hydrogen from deteriorating the fabric.

The modern captive balloon is often popularly, but erroneously, called a "sausage." The sausage type, the Drachen, originated in Germany, and is now obsolete. There is an American balloon, the Goodyear, which closely resembles the Drachen. It has sails and a parachute tail to assist its stability. The Italian balloon has an elliptically-shaped gas-bag provided with a conical-shaped tail filled with air, to which a rudder and stabilising fins are attached.

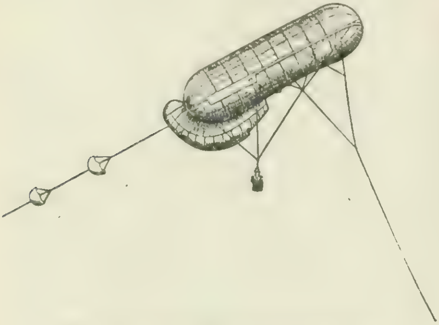
FIG. 1.—"SAUSAGE" BALLOON (DRACHEN).

The French balloon, however, is the most important and most widely used. It is the standard for the Naval and Military Services of England and France.

The streamline form for a kite balloon is rather bluff (i.e. not sharp-pointed at the ends) and short compared with an airship. The latter has its centre of buoyancy, or central point of the lifting effort of the gas, immediately above the car. This allows a finer nose on the streamline. Conditions are different in the case of the kite balloon. Here the greater part of the gas-lifting force is required to lift the cable, and bear the tension on the cable due to the wind forces on the balloon. A large amount of buoyancy is therefore needed about the nose, where the cable suspensions are attached, and that is why the balloon is given a "bluff" nose.

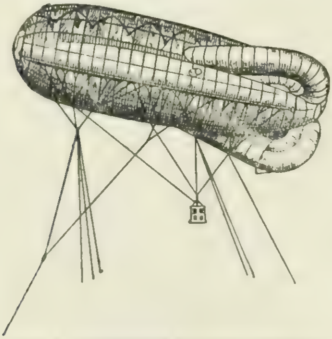
FIG. 2—STREAMLINE BALLOON (CAQUOT).

On the right-hand side of the balloon in Fig. 2 are seen the air-filled stabilising fins and the rudder. To these large fins the kite balloon owes much of its success.

Kite balloons, like airships, are provided with an internal air-chamber or "ballonet." The function of the ballonet is to keep the balloon rigid, and to provide an automatic means of operating the valve which releases the hydrogen from the envelope as the balloon ascends.

A kite balloon of capacity 35,000 cubic feet can be flown at altitudes up to 6,000 feet, carrying two observers. Such a balloon is about 91 feet long, and is the type used for "spotting" enemy batteries and for controlling gun-fire in military operations. For naval work, and for operations where great altitude is not of importance, a slightly smaller balloon has been found more convenient. During the war much valuable work was accomplished at sea in convoying ships, a lookout being kept for the wake of a submarine by the balloon observer. A submarine can be seen beneath the surface just as fish can be seen in a clear pond. The balloon is towed by a ship, usually a destroyer or a boat of the new "P" class, the observers in the balloon being in telephonic communication with the ship by means of a wire in the core of the cable. Messages may thus be sent without delay, enabling the ship on occasion to know the exact place and time to drop their depth charges so as to destroy the submarine. These charges take effect anywhere within 50 feet of the explosion, and their effect is felt in the balloon itself at altitudes from 600 to 1,500 feet. On one occasion a depth charge caused the magazine of a large U-boat to explode, and the effect was so far-reaching that many of our own ships, some even sixty miles away, felt it very much. In one instance the crew came up on deck expecting that the stern of the ship had been blown away, although in reality they were many miles from

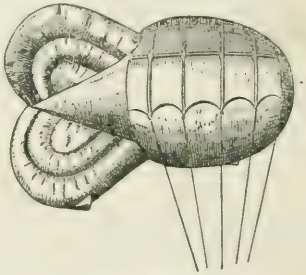
FIG. 3.—ITALIAN.

the source of disturbance. Other ships felt that they had been lifted bodily out of the water.

Not a few convoyed ships owed their safety to the towing of a balloon which was carrying no observers. The mere appearance of a balloon, empty or otherwise, made it advisable for the submarine commander to keep well below the surface. He was thus unable to come to the surface to attack our ship. Decoy balloons were just as effective in keeping the U-boats beneath the surface. These were small and cost little, and yet they deceived the enemy both as regards distance and object.

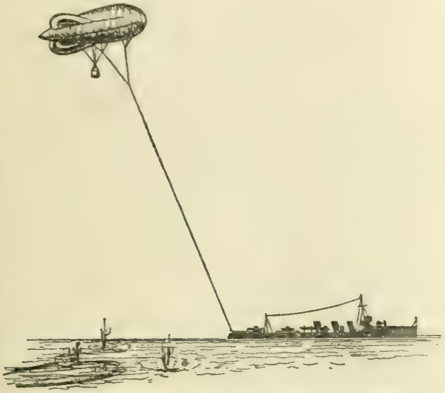

FIG. 4.—TOWING FROM DESTROYER IN ACTION.

Kite balloons are capable of being released from the cable and given a free flight in the same manner as a spherical balloon. A kite balloon of 33,000 cubic feet capacity would reach an altitude of about 9,000 feet or more with two occupants when free.

Parachute descents afford, perhaps, the most thrilling experiences of balloonists in war. The parachute is to the airman what the lifebuoy is to the seaman—a means of saving life. Two parachutes folded in cases are always carried on the side of the balloon-car or basket. These are attached to harness worn by the occupants. A parachute is about 26 feet in diameter and is made of silk, so that it is easily folded into a small bulk. If the balloon is attacked, or if, for any reason, it is necessary for the occupant to quit the car, it is necessary for him to jump out. In doing so his weight snaps a small cord, or operates a spring, which opens the case and allows the parachute to glide out. It is not till the parachutist has fallen about 200 feet that the parachute has fully unfolded, and is then able to support his weight. This takes several seconds, and consequently it is rather a trying time for the parachutist. It is obvious that the folding of the parachute must be done with great care, and men are specially trained for the purpose, and the man who may have to do the jumping usually prefers personally to superintend this operation. There is a parachute called the " positive-opening " one, in which wooden ribs are automatically pushed out, forming the dome. This has not been used extensively with kite balloons. It is a recent development.

The speed of descent with a parachute is about 900 feet per minute. As to his landing-place the parachutist has to trust to luck. At sea he would be provided with a life-saving waistcoat, but on land he must just hope for the best. Sometimes the observers have drifted into the enemy's lines; on other occasions, after drifting towards the enemy's line, a wind in the opposite direction at a lower altitude has kept them on the right side.

One of the highest descents undertaken was made by a well-known airman from a spherical balloon about 10,000 feet up. The writer was told by the pilot that he was asked by the hesitating parachutist to push him off the edge of the basket. It cost the pilot nearly as much nerve to do this as to make the descent himself.

In France and Italy arrangements are made on some balloons for the complete basket and occupants to be released if necessary by the touch of a lever, the whole being supported by a parachute making a free descent. The gear has not found favour in this country. One of the objections to the arrangement is that in war an enemy gunner is less likely to attack a helpless man descending in a parachute, than a basket containing men who might be free to use firearms. Valuable instruments, and complete records of observations made, are saved by the basket method of descent. This, of course, would induce the enemy the more to shoot.

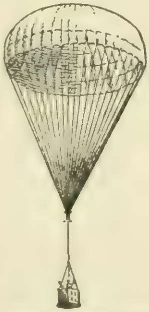

FIG. 5.- BASKET METHOD OF DESCENT.

Kite balloons are sometimes unfavourably compared with airships, but a comparison of advantages is hardly fair, as the nature of balloon work may be in many cases entirely different from that of airships. A small airship is not capable of putting to sea in bad weather, and it is at all times dependent upon housing facilities on land. A balloon, on the other hand, can be kept at sea either aboard a ship or aloft. A balloon has been towed in the Bay of Biscay in winds approaching ninety miles per hour. In commercial life the kite balloon seems very useful in many undertakings. Large areas of unapproachable or untrodden land may be surveyed from photographs taken from balloons. Many rivers run in deep ravines, the precipitous rocks shutting out completely the view of the land beyond. In a balloon towed from a shallow-draught boat, a surveyor could obtain by photograph and from observation the data he needs for his map.

The captive balloon is also used in making meteorological observations. Periodical ascents are made at balloon stations for ascertaining weather conditions. A large observatory would find a kite balloon valuable for this class of work, and observations could be made up to heights of 14,000 feet.

During the war balloons were put to an ingenious use. Long wire streamers were lifted into the air, making an apron from one balloon to another. This formed part of the defence of London. Raiders had to risk being caught in the net, or forced to ascend to high altitudes, and thus lose accuracy in bomb-dropping.

In the future it is probable that kite balloons will be used as landmarks for the main aerial lines over the world. At landing-places for aeroplanes and airships they could exhibit lights or flares at night, possibly even display searchlights. At sea they could be anchored in much the same way as lightships are. It has also been suggested that balloons be used for locating shoals of fish. A suitable one for this purpose would cost about £800, and could be handled conveniently by a trawler.

Hydrogen is the best gas to use for filling a balloon because it is the lightest. The lifting-power of the balloon is proportional to the weight of a given volume of air minus the weight of the same volume of the gas used. It is thus greatest when the weight of the gas used is smallest. Helium, which is the second lightest gas known, has also been tried. It is twice as heavy as hydrogen, but its lifting-power is 92 per cent. of that of hydrogen. It is a rare gas, and so it is much more expensive than hydrogen. It has, however, the great advantage of not being inflammable, so that in war, where cost is of less importance than safety, it has obvious advantages. Helium is made on a large scale from natural gas in America.

The New Horizon in European Literature

By J. G. Robertson, M.A., Ph.D.

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In the general stocktaking in which, as a preparation for reconstruction and new beginnings, we have all been instinctively indulging, literature has not had altogether its share. A reason lies probably in the elusive waywardness of all forms of imaginative activity; we feel that no amount of stocktaking and no schemes of reconstruction will avail in giving direction to the production of the future. Whatever new realms the poet is to conquer, on whatever new argosy of spiritual discovery he is to embark, he sets out with sealed orders; stocktaking is of little use to him, even in helping him to avoid the errors of his predecessors; the best of plans are ignored by the world-forces that control the evolution of æsthetic ideas. We may plan and forecast new conquests in chemistry, in biology, even in the more abstract sciences which trench on the borderland of metaphysics; but when it is a question of the new ideas which poetry is to embody, and the new forms it will assume, we can only patiently await events.

It is still too soon to report, as it is the obvious duty of DISCOVERY, a modern Lynceus on its watch-tower, to report, on the progress of European literature "after the War." Literature has not yet progressed; it has not even clearly indicated how it is going to progress. Possibly we may have to wait some time for real signs. Such, at least, was the experience of the last European war, that of 1870–71, when the literatures of France and Germany proved strangely dilatory in adapting themselves to the new orientation; in fact, the real effect of that war on literature only became apparent when the generation that was mature in 1870 had abdicated, and the men born into the new era were old enough to take command. It may be so again.

Hypotheses of literary evolution can only be constructed on the analogy of the past. Now, how far may we avail ourselves of analogy in setting up a hypothesis of the lines on which imaginative work is likely to advance? In general, literatures are freakish, capricious, perversely undocile in their development—with perhaps the single exception of that of Germany. This, the most subjective and personal of them all, and consequently, one would expect, the least open to guidance, has shown itself quite extraordinarily ready to follow the lead of its theorists. The Germans, we other Europeans might say, have always put the cart before the horse; they have, since the sixteenth century, invariably theorised about their literature before producing it, and their poets—even in revolutionary periods—have meekly resigned themselves to the dictates of criticism. Were other literatures conducted on similar orderly lines, it would certainly make our attempt to peer into the future an easier and more fruitful task than it is.

Some months ago an enterprising Scandinavian literary journal, *Litteraturen*, organised an inquiry on the probable effect of the European War on literature. The results were disappointing in so far as the part which writers other than Scandinavians took in it was small; three or four of our English writers responded, but France was hardly represented at all. From the replies one might conclude that the older generation is inclined to be sceptical of the good that will come out of the War: Dr. Georg Brandes, the doyen of Scandinavian critics, is, for instance, frankly pessimistic; to him the War has been merely the undoing of a century of literary evolution, a throwing back of Europe into barbarism. But Brandes' whole attitude to the events of the last five years has been, in spite of the liberation of North Slesvig, Poland, and Palestine, a peculiar one. On the other hand, the younger generation appear buoyantly confident that the new era will be really a new era, although they may not be very clear as to wherein the novelty shall consist. They hope, at least, that the literature of the future will be characterised by a larger-hearted humanity than the literature of the past, and will abandon its preoccupation with the individual, to seek inspiration in problems of society, of nation, of race. This, however, is an attempt to answer only half the problem; it leaves the question of the fashioning of the new literature untouched.

Beside a natural reluctance to take stock in literary matters, there is another factor which has to be reckoned with. Those whose business it has been to follow the evolution of literature in the past generation have a disheartening record to lay before us. Quite frankly, European literature had, in 1914, reached a point not very far off bankruptcy. We hasten, however, to add that we are not here thinking of individual achievement; but of the ideas, tendencies, and form of literature. The literature of the mid-nineteenth century—to look somewhat farther back—moved in all countries on a monotonous, uninspiring level; the dead hand of a moribund Romanticism—or was it the disillusionment of 1848?—lay heavy on it; we in this country called it Early and Mid-Victorian; and something very like Early Victorianism was to be seen in all the greater literatures of Europe, the representative writers being either belated romanticists or disgruntled revolutionaries. Only in the little nations, from the young and virile literatures of the North and, to some extent, from the grotesquely old-young literature of Russia, were new voices to be heard; but these voices were unable to gain much hearing amidst the general pessimism and conventionalism that held Europe in its bann. The first step towards regeneration is to be seen in the movement known as realism or naturalism. The generation that was young in the seventies and eighties of last century pinned their hopes on the new faith, flocked enthusiastically to its standard; literature, they proclaimed—unmindful of the fact that every fresh movement in literature justifies itself in almost identical terms—was to be no longer a juggling with threadbare motive and banal expression; it was to be life, to be a fresh vision of reality, reality "seen across a temperament." For a time all went well; the new wind swelled all sails; progress was rapid. Realism in literature became increasingly realistic; and before long the pioneers were set aside by a more resolute generation, who, accusing their predecessors of half-heartedness, unmasked their former leaders as really incorrigible romanticists at heart; a "consistent" realism took the place of a mere realism of "compromise." And then, with a suddenness which is not easy to account for, realism petered out. The ineradicable craving for something more inspiring than photographic truth reasserted itself; overnight realism had become out-of-date; even its most ardent adherents were forced to admit that their shibboleth was powerless to create a new heaven and earth in poetry. In its place came first what was camouflaged as psychological realism, then a new symbolism, a new spiritualism—all concessions to idealism, which were suspiciously like the old effete thing once repudiated and scorned as romanticism. The realistic creed disappeared amidst contemptuous phrases like *fin de siècle* and the like; once more a new foundation was laid down, and the optimists were confident that on it the twentieth century might hopefully build. If literature, they said, can widen its spiritual horizon and still maintain that sense for reality acquired in the previous period, it may escape the danger of drifting back into the deadening conventionalism under which latter-day romanticism had suffered. But the new formula, the second within the experience of one generation, proved to be no more a remedy for the decadence than its predecessor. The post-realistic movement was ineffectively tentative, without whole-hearted backing; its timid and hesitating experimenting was no substitute for the discarded realism; and thus, when 1914 came, literature was still in most countries floundering in the morass of "fin-de-siècclism."

This, briefly, is the main reason why literary stock-taking has not been an alluring or profitable undertaking in these times; we have had nothing very creditable to take stock of. But there is a brighter side to the confession of failure ; it is the most valid of reasons why the future should be faced with hopefulness. The War has been to many the end of an old bad period. Does not, indeed, Professor Babbitt, in his latest book, *Rousseau and Romanticism*, even hint that it was a kind of Nemesis upon us for not having got rid of our romantic ideas long ago ?

What has history to tell us of the effect of national wars on literature ? The generation of to-day, schooled in a more critical scepticism, cannot answer this question with the same easy confidence as their Victorian predecessors ; it used to be a commonplace to say that periods of expanding national life, of great wars and great victories, inspire great literatures. We talked with full conviction of a Periclean Age and an Elizabethan Age and all that such phrases implied. But the study of the psychology of nations has tended to discredit such simple theories ; the relationship between literature and national life is a more subtle and complicated thing than was once believed ; we are not now so sure that Elizabethan poetic greatness had much to do with the Spanish Armada. The rôle of literature seems, in fact, rather to be prophetic, a foreshadowing rather than a consequence of political and social movements. Take, for instance, the literature of Germany in the generation that precipitated the catastrophe ; it did not exactly predict the War, but it displayed, for those who saw beneath the surface, the kind of mentality which made the War possible and even probable. Moreover, the foreshadowing of coming events is to be found not so much in literature itself as in the interpretation a people puts upon its literature ; it is rarely due, unless in quite minor manifestations, to any conscious collusion on the part of the poets with the spokesmen of national aspiration. One thinks of Nietzsche, whose whole system of thought, essentially anti-Prussian and even anti-German, became perverted in the imagination of his countrymen to provide a justification for aggressive Prussianism. And most revolutionary dramas are not discovered to be revolutionary until they are performed in the theatre.

Of the aloofness of literature from great political cataclysms there is no lack of striking illustration. Can one honestly say, for instance, that the reflex of the French Revolution in literature is even remotely commensurate with the significance of that upheaval ? Here, again, there is more French Revolution in the literature of Europe before 1789 than after that year. And how little can we point to in English literature as the poetic sublimate of the Napoleonic Wars ? Political poetry is notoriously an inferior brand ; it does not stand the test of time. Thus we are not at all sure that the literature of the future, either amongst the victorious nations or with the Germans—and it is by no means a matter of course that the advantage in these things lies with the victor—will bear upon it signs of regeneration directly traceable to the struggle. The real business of literature—*pace* the school of critics which holds that the vitality of literature consists in its capacity for bringing problems under debate —is with matters foreign to the clash of political ideas. Indications are not wanting, indeed, that the new literature may even begin by setting itself resolutely to ignore the War ; and will rather seek in remote, imagined worlds, a relaxation from the strain of the intolerable five years.

But to the literary historian the vital question is : Will literature succeed in disengaging itself from the catchwords and coterie-spirit of the past ; will it escape from the eternal see-saw of classicism and romanticism, which has dominated literary evolution since the Renaissance ? Can the circle of necessity, the " ewige Wiederkehr " of the Nietzschian philosophy, be broken? Or are we doomed to go on through another century helplessly oscillating between the old opposites of individualism and collectivism, realism and idealism ? Bearing in mind the ineradicable romanticism of the nineteenth century, we may reasonably look to the future for a reversion to collectivism—and in literature collectivism is usually synonymous with classicism—look for greater literary solidarity among the nations. Twice, and twice only, in the past, has all Europe been inspired by the same ideals, has thought and felt as one great nation ; the first time was in the epoch of the Crusades, the second in the eighteenth century. It surely does not savour too much of prophecy to say that the twentieth century will probably resemble the eighteenth rather than the nineteenth. But the solidarity of the future must not mean, as too often in ages of classicism, the negation of individualism. It has been decreed that the rights—and these surely include the thought and literature—of the little nations are to be henceforth held sacrosanct ; individualism must be a factor in the new solidarity ; in any case, it is inconceivable that Europe should ever again resign itself to the grip of an ice-age like that of pseudo-classicism. Thus the problem of the immediate future will be, it seems to us, to find a formula that will reconcile the collective and the individualistic spirit in literature. And if we are not mistaken, there are some signs of a development of this kind in the smaller nations themselves ; we are thinking more particularly of Scandinavia. The mere desire on their part to be known sympathetically to the great world outside brings with it an ambition to speak a common language of thought and emotion ; to set forth their individual contributions to thought, not in the old, aggressively national spirit of the romanticists, but in an honest effort to win understanding for them.

But this, we fear, is not "discovery"; it is at best but a reasonable anticipation. We trust that future issues of this Journal may, as the horizons become clearer and as opportunities offer, testify to the shaping of the new literatures and to the spirit in which they are facing the tasks that lie before them.

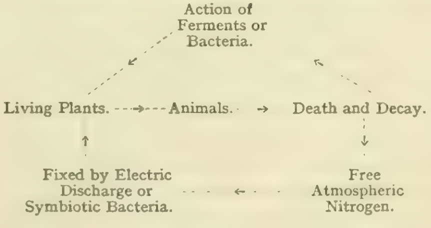
The Source of Nitrogen, Old and New

By Edward Cahen, A.R.C.Sc., F.I.C.

All living plants and animals require nitrogen if they are to exist, and in addition to this, man, the noblest of all the animals, uses this element in huge quantities for the purpose of putting an end to existence by means of his great invention—firearms.

The earth on which they have their being is a sphere of some 8,000 miles in diameter, around which there is an envelope about twenty miles deep of air, four-fifths of which is nitrogen, and yet these plants and animals, with but few exceptions, are unable to make use of all this good nourishment unless it is specially prepared for them. As far as one can see, this enormous quantitiy of nitrogen is merely mixed with the oxygen to dilute the latter for our consumption. Rutherford (1772) is usually credited with the discovery of nitrogen. He burnt various elements, such as phosphorus and carbon, in air, and observed that what was left had lost something; he therefore called the residue "phlogisticated air." It was not till much later that Chaptal (1823) gave it its present name Nitrogen, from the Greek *νίτρον* (saltpetre) and *γεννάω* (I produce), in reference to its existence in this material. Nitrogen is one of the most ubiquitous of elements; not only is it a constituent of all living plants and animals, and supplies four-fifths of our atmosphere, but it is also found in some nebulæ in the heavens, and has been discovered hidden away in many minerals. If agriculture is to be developed, a supply of suitable nitrogen must be found. At first, of course, the manure from stables and cowsheds was enough to meet the small demands; but, when more and more land came under cultivation in the course of the ages, more and more fertilisers had to be found. A fruitful source of supply in the past has been the saltpetre beds in the rainless region on the West Coast of South America—in Peru, Chili, and Bolivia; but, large as this source is, it cannot last for ever at the rate at which it is being used up. Although in 1873 there existed some 550 square miles of these beds in large flat basins between the ridges of the Tarapueca plateau, every square mile of which was capable of producing about four million tons of the precious material, it was estimated that these beds could not last much more than a hundred years. There is another disadvantage about a source of nitrogen so far across the seas, and that is, it is not always available. A war arises, a blockade is declared, and the supply is cut off at just that time when it is most needed for the making of munitions. Not only during this war has the lack of nitrates made itself felt, but even during the Napoleonic Wars, France was in such desperate straits for the lack of them for making gunpowder that she had to resort to what were known as "nitre-plantations." These were simply great heaps of manure protected from the rain and allowed to rot; in course of time several different kinds of bacteria set to work and converted the nitrogen into nitrates. This method of obtaining nitrates is still resorted to in hot countries such as Bengal. In this connection it is interesting to speculate how the Chili deposits of nitrate got there; the problem in point of fact is a very difficult one, and has not yet been solved in a satisfactory manner. It is thought that the sodium nitrate might be of animal origin, but in that case, where the phosphates which must at one time have been associated with them have gone to, is more than one can tell.

In nature there is a complete cycle round which the available nitrogen moves: the verdure covering the surface of the world is consumed by the animals; these die and decay, part of the nitrogen going back into the soil to nourish the vegetation, part returning into the atmosphere, where a thunderstorm, with its flashes of lightning, soon oxidises it to nitric acid, which dissolves in the rain and so is returned to earth. This cycle is not quite so simple as I have described it, but a glance at the diagram will at once make matters clear. The symbiotic bacteria in the diagram are rather interesting little bodies; they live in a sort of partnership in nodules on the roots of plants, mostly of the bean family (Leguminosæ), and in return for their board and lodging they make the atmospheric nitrogen palatable for the plants, their landlords. It was perhaps to be expected that, when the natural sources of nitrates began to get more scarce and more difficult to come by, the ingenuity of man should be


Action of Ferments or Bacteria.
Living Plants.
Animals.
Death and Decay.
Fixed by Electric Discharge or Symbiotic Bacteria.
Free Atmospheric Nitrogen.

attracted to the vast quantities of nitrogen in the air as a possible source of supply, if only a means could be found of converting the nitrogen into nitrates at a reasonable cost. In solving this problem, perhaps the greatest problem of the day, the scientists first of all turned to nature to find out how she accomplished the process, and to see whether they could not take a leaf out of nature's book. Now, if we glance at the nitrogen-cycle diagram above, we at once see two methods suggested, both of which have since been imitated on a commercial scale with success; and in addition two new methods have been discovered which are capable of competing with the Chili saltpetre on a commercial basis. Of these four methods only one is independent of cheap electrical power; this is based on the culture of nitrogen-fixing bacteria, the symbiotic bacteria to which reference has already been made. This was done by Nobbe and Hiltner in 1896, who sold these cultures for soil inoculation under the trade name of " Nitragen."

The electrical methods are, however, of much greater interest, and appear also to be sounder commercial propositions as well.

Of these the *Norwegian Process*, as it is often called, was based on an experiment of Cavendish (1785), though really it only reproduces on a small scale exactly what happens during a thunderstorm. Cavendish's experiment was in itself only a refinement of one performed by Priestly (1779) ; it merely consisted in passing sparks in a small quantity of air in an enclosed space; he thus caused a little of the nitrogen to combine with the oxygen to form oxides of nitrogen, which dissolved in water, with the production of nitric acid. The miniature thunderstorms of Cavendish and Priestly were improved upon by Siemens and Halske (1902). They arranged a powerful arc light in an enclosed space through which air could be drawn; then they spread the flame of the arc with a strong electro-magnet, thus getting the maximum volume of flame from the minimum of current. As the air was drawn through this immensely hot flame, combination took place, and oxides of nitrogen were formed. From these beginnings the process of Birkeland and Eyde (1905) was developed, until to-day in Norway, where electric power is cheap owing to the abundance of waterfalls, huge generators are producing nitric acid directly from the air. In its broadest outlines the process is not difficult to describe. A current of many thousand volts produces an enormous flaming arc between terminals of copper tubing, through which water continually flows ; the whole is enclosed in a furnace-like box of brick with metal casing. An alternating current is employed so that the arc passes from pole to pole every one-fiftieth of a second, and in addition a powerful electro-magnet spreads the flame. Through this arc, resembling a great ball of flame some 6 feet across, a current of air is allowed to pass, and in its passage the nitrogen in it partially combines with the oxygen, its partner, to form oxides of nitrogen. The gases are then drawn off up a series of towers, where they come into contact with dilute nitric acid and milk of lime. This latter combines with the nitric acid, and the salt (calcium nitrate) resulting from this combination fixes the atmospheric nitrogen in a form suitable for use as a fertiliser. This is sold as Norwegian saltpetre. Such a process, however, is only possible where very cheap electric power, obtained from a natural source, is available ; two other processes have for this reason been developed, which are capable of being run on commercial lines from power derived from coal. Both of them depend on the production of ammonia from nitrogen, separated from the air, by making it combine with hydrogen, a matter of no small difficulty, for nitrogen is, with the exception of the rare gases of the atmosphere helium, argon, xenon, neon, and krypton, perhaps the most inert of all the elements. This inertness of nitrogen is very curious, when one considers how extremely active this element becomes, for good and evil, when properly combined. Not only are the fertiliser and the explosives industries at the mercy of the nitrogen atom, but the dyeing industry as well owes its being to this remarkable element.

The first of these two processes is usually referred to as the *Cyanamide Process*, because this compound is the characteristic feature of the method. As yet Norway is the home of this process, but it is a British company that is responsible for the operations involved. Calcium carbide, the familiar material used for the production of acetylene gas, is first of all manufactured on a gigantic scale. Lime and coal are heated together in an electric furnace the temperature of which reaches something like 3,000° C. The carbide, after cooling, is ground to a fine powder in an atmosphere of nitrogen, a precaution which is necessary so as to avoid explosions, which might otherwise take place from the accidental production of acetylene. Incidentally use is here made of the inertia of nitrogen, a property referred to above.

The powdered carbide is then placed in large cylindrical furnaces, through the solid lids of which a carbon electrode passes down the centre of the furnace. Nitrogen is kept percolating through the powder, and the temperature is gradually raised to about 1,100° C. by the current till combination takes place and cyanamide is formed. This substance, a compound of calcium, carbon and nitrogen with some free carbon, which is liberated during the reaction, is known commercially as " nitrolim." The nitrogen used in the manufacture of cyanamide from calcium carbide is itself a by-product in the Linde or liquid-air process for the preparation of oxygen from the air. The nitrogen can be used directly as a fertiliser, and it can also be converted by suitable treatment into ammonia or the cyanides, which are used in countless metallurgical processes. If nitric acid is required, this can be obtained from the ammonia by making use of a catalyst. These substances are of great importance to the chemical manufacturer, for though they bring great changes about, they themselves remain unchanged at the end of the operation. Spongy platinum, which by the way is now worth more than £40 an ounce, is the catalyst used in this case, so perhaps it is fortunate that it suffers no change in the operation, and can be used time after time. That this process was employed during the war in Germany and the United States is now common property, and it is rumoured that a plant is to be set up on one of our coal-fields, from which the power is to be derived. That this is a commercial proposition in times of war has been proved by both Germany and the United States; whether it will pay in times of peace is another matter, and a point that the future alone will decide.

We now come to the last process, the much discussed *Haber Process*, named after the inventor. Essentially this is a process for the production of ammonia synthetically from its elements nitrogen and hydrogen, a matter of no little difficulty, as I have already indicated above, on account of the lazy habits of the element nitrogen. By means of a suitable catalyst this can, however, be brought about. As in the cyanamide process, the nitrogen is first separated from the oxygen; the hydrogen is obtained by blowing steam on to an incandescent mass of partly coked coal. The gaseous ingredients are then mixed in the right proportions, heated and subjected to the action of pressure and a catalyst. Round the choice of a suitable catalyst and the proper pressure to use the controversy has raged. Several catalysts have been used; finely divided pure iron, osmium and uranium may be mentioned here. However, the fact remains that, under these somewhat exacting conditions, nitrogen may be prevailed upon to enter into partnership with hydrogen, although somewhat reluctantly. This process, which was originally a jealously guarded secret of Germany (a secret which no doubt saved them from collapse due to a lack of munitions), is one to the perfection of which a great deal of patient research has been devoted. The object of this research has been to find the best working conditions, to produce the greatest yield of ammonia at the lowest figure. This latter point is very important in times of peace, when other sources of nitrates are available. Only a few days after the publication of the long-delayed "Report of the Nitrogen Products Committee," *The Times* announced that the rights of the new French *Georges Claude Synthetic Ammonia Process* had been secured for the United Kingdom and the Colonies by the Cumberland Coal, Power, and Chemicals, Ltd., who intend erecting works in the West Cumberland coal-fields as quickly as may be. This new process was developed by M. Georges Claude at the works of the Grande Paroisse, Montereau, near Fontainebleau, and differs from the Haber process in several very important essentials. The chief of these appears to be a matter of pressure; whereas the Germans used a comparatively low pressure of from 150 to 200 atmospheres, the new process employs as many as 1,000, or 14,000 lb. to the square inch. The advantage gained in increased yield compensates for the increased cost of producing this enormous pressure. It is estimated that the first Synthetic Ammonia Plant to be erected will be capable of producing some 50,000 tons of ammonium sulphate annually. This process is particularly suitable for this country, where we have no great natural sources of electrical energy, but good supplies of coal, which at any rate are adequate for our present needs. At a time such as the present, when so much is being done to revive agriculture in this country, and when freights are so high, it is a matter of the greatest importance for these islands to be rendered independent of other countries in the matter of fertilisers. The outlook for the future is rather more hopeful if these two great schemes to which I have referred culminate in success. During the war a great deal of the most useful research has been done on this subject, and the recommendations in the report of which mention has already been made seem likely to bear fruit in the near future. The Government erected a huge factory at Billingham-on-Tees, but this had not been used when the Armistice put an end to the war and the immediate need for nitrates for explosive purposes. The factory is now for sale, and there seems no reason why it should not be turned to the use for which it was designed. Should it be found possible to render this country independent of foreign fertilisers, the benefit will be found in another way: agriculture will become far more intensive, imports of foodstuffs will diminish, and our exchange will again tend to be stabilised, a condition which is devoutly to be hoped for in the not distant future.

NOTE.—Several illustrated articles have appeared in the *World's Work* on this subject, and there is a popular article, with some good illustrations, in the January number of *Conquest*. Any large textbook on Chemistry gives a description of the several methods. The "Report of the Nitrogen Products Committee" just issued discusses the matter very fully in all its bearings. This is a most important report. In vol. vi of *A Textbook of Inorganic Chemistry*, edited by Newton Friend, and published by Charles Griffin, will be found a very full description of Nitrogen. This volume is in the press.

Jute-Dyeing

THIS fibre is one of the most interesting, if not one of the most important, that finds great and growing application in the textile industry, possessing many qualities that are not shared by other fibres of similar origin, and which are valuable factors in directing its use for the manufacture of certain classes of fabric that are of considerable commercial value.

To many persons jute is synonymous with burlap, which is used for bag manufacture; but since processes have been found that enable the fibre to be bleached and dyed in a satisfactory manner, the plebeian idea of the use of jute must be set aside and a more refined position given it.

A tour through any of the large department stores in large cities in America, or inquiries at any interior decorating establishment, will convince anyone regarding the wide range of uses to which jute is put, while its popularity from an artistic standpoint will not be overestimated.

The jute plant has been known and raised in India from the very earliest times for the valuable properties of its fibre, but it has only been since the beginning of the nineteenth century that the systematic treatment of the plant for its fibre for use in textile manufacturing received any attention. As a matter of fact, the only textile manufacture that jute was consumed in for many years was the manufacture of continually increasing quantities of bagging for use in baling the American crop of cotton. It was not until the late sixties or early seventies that jute bagging became the article almost exclusively used for this purpose, and consequently the jute industry—not alone from the agricultural viewpoint, but from the manufacturing viewpoint as well—has increased to immense proportions, and there is a prospect that it will continue to grow, for the reason that we have not in sight any other fibre that is fully able to take its place.

Jute fibres are obtained from that part of the plant known as the bast, which consists of that portion of the stalk next to the outer crust or rind. This appears, when viewed under the microscope, to be made up of innumerable "bundles," which are actually the fibres of commercial value. The scientific name is *Corchorus capsularia*, while the common names are too numerous to be given.

The plant grows to a height of from 5 to 10 feet, the average diameter of the stalk being over half an inch, with few branches except near the top. While the jute plant had been cultivated in many parts of the world, India retains its pre-eminence in this regard, the greatest crops of the fibre being raised in Bengal.

The commercial fibre is separated from the plants by treatment with cold water; the leaves, branches, and capsules are removed from the stalks. These are immersed for several days in a stream of slowly moving water, at the end of which time the fibre portion may be removed without any difficulty, and in considerable purity. The dried fibre is made up into bundles, the length of which varies from 6 to 8 feet. For textile manufacturing purposes, not all of this length is utilised; about 12 to 14 inches from the thick end is usually cut off, and finds its outlet in the manufacture of paper stock, under the name of "jute butt." That portion of the fibre used for textile purposes is softened with an emulsion of soap and oil, and is afterwards hackled and spun into threads, and then woven into cloth, or otherwise utilised.

Jute, unlike many of the vegetable fibres, though used for coarse fabrics, requires considerable care, as it is incapable of resisting harsh treatment.

While there are known a number of practical processes for bleaching jute, the one yielding perfect results is yet to be discovered. Those which follow, however, are to be recommended only by the fact that they are at this date actually used in various mills where jute is treated.

For Jute Pieces.—Pass through a ½ per cent. solution of silicate of soda, heated to 160° F., then through a second solution of sodium hypochlorite of such strength that the vat does not contain more than 1 per cent. of chlorine available for bleaching as determined by a volumetric test. This hypochlorite is made by acting on a fresh solution of bleaching-powder with one of soda ash, adding the latter until no further precipitation of calcium carbonate is noted, let settle, and draw off the clear portion for use, diluting with water until the proper strength is obtained.

After passing through this solution, the goods are well washed and passed through a weak muriatic acid solution, to which has been added a small quantity of sulphurous acid. This treatment is to ensure the removal of certain substances that tend to discolour the otherwise bleached material, and also to remove the small quantity of iron that is always found in the crude jute fibre. Finally, wash well and dry, but, if it is intended to print colour on the fabric, pass the cloth through a solution of bisulphate of soda containing about 2 per cent. of sulphurous acid, squeeze the excess of liquor out of the cloth, allow it to lie covered with damp burlap for three or four hours, and afterwards dry over cans. This treatment leaves only neutral sulphite of soda on the fibres, which does not affect the printing colours during steaming, but preserves the fibre against the oxidising action of the steam-chest atmosphere. The loss in weight by this process is sometimes as great as 8 per cent.

Another process is to subject the jute alternately to the action of potassium permanganate and sodium bisulphite, but the cost is against it, although the results are very good when properly conducted.

A perfect bleach is almost impossible to secure, as the fibre will not stand the necessary treatment. The only way to obtain passable results is to bleach with the first process above indicated, and then to make use of a tinting blue, for which purpose some of the so-called "soluble blues" answer very well.

Jute, like all the other fibres of similar origin, is not very difficult to dye; but unlike most fibres, unless some special care is taken, uneven results will always be obtained, owing to the great affinity that the fibre has for most colours.

At the present time, three broad classes of dyestuffs are required as being of particular interest to the jute-dyer—namely, the basic, acid, and direct colours, each class having advantages over the others according to the uses to which the dyed fabric is to be put.

Dyeing Jute with Basic Colours.—Prepare the dye-bath by heating the water to about 80° or 90° F., work the jute for a few moments to ensure that it is evenly wetted, and then add a portion of the dyestuff, previously dissolved in warm water; gradually increase the temperature to 175° F., at the same time making further additions of dyestuff until the proper depth of shade is required. Move about in the dye for twenty to thirty minutes after the last addition, and then lift, wash, and dry.

Some basic colours may be dyed at a temperature of 180 to 190 degrees at the start, but they are so few that it is unnecessary to mention them. Others of this same class require for the best results the addition of a small quantity of acetic acid, usually a pint to a kettleful of water; such dyes being the methyl violets and malachite (acid) green.

Dyeing Jute with Acid Colours.—These colours always yield the brightest shades, and are applied to jute from a dye-bath made slightly acid with about 2 per cent. of oil of vitriol, together with 5 per cent. of alum.

The colour is added slowly during the heating of the bath until it boils, when the steam is shut off and the yarn or pieces worked for half an hour. Lift, wash, and dry.

Dyeing Jute with Direct Colours.—This class of colours is always applied to jute from an alkaline or neutral bath, and is receiving very great attention from dyers and manufacturers of burlap for interior decorations, for which purpose these dyes are better suited than any others, as they are fixed more permanently upon the fabric, and do not fade under the influence of light.

A general recipe for dyeing yarn is as follows:

1 to 3 lb. direct colour.
10 to 20 lb. Glauber's salt.
1½ to 2½ lb. soda ash.

Put in the yarn at 180° F., raise the temperature to the boil, and keep boiling for one hour, or until the bath is exhausted or the proper shade is obtained. With light percentages the colour is quickly taken up, but with heavier shades it will be found economical to maintain the standing kettle. Lift, wash well, and dry.

Burlap for decorative purposes is always dyed in the piece, and with colours that will not be acted upon by the glue sizing that is put on the back of the finished fabric. Some manufacturers are using casein as size for the burlap and with very good results. For dyeing the piece-goods burlap, a padding machine is always employed, as this enables the dyer to obtain in a very short time the heavy shade usually required. The colour-bath is made up with a very small quantity of water, just sufficient to fill the box of the machine, and to this is added a small amount of some soluble thickening

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such as dextrine or casein. This latter product has many advantages over any other similar material, and yields very good results on the finished piece.

The " colour " is made up in a cask or barrel, without any other addition than the thickener, and then poured into the " sow-box," or trough of the machine, giving the pieces two runs in opposite directions so as to secure shades. The padded goods are well squeezed through nipping-rollers, and then dried and " backed." The temperature of the colour-paste should be boiling or nearly so, because the higher the temperature the better the penetration.

Printed patterns or designs are often applied to jute, and the process is exactly the same as for calico-work, except that the colour-paste is made very much thicker, and that the colour in a number of instances is not fixed by steaming.

Often white figures are printed upon the dyed burlaps, these being made up of white pigment, such as *blanc fixe* thickened with albumen or casein.

As a wall-covering burlap is certainly one of the most satisfactory to be had, and it will no doubt continue to increase in popularity.

The Treasures of Coal-Tar

If you put a bit of soft coal into a test-tube (or, if you haven't a test-tube, into a clay tobacco pipe, and cover it over with clay) and heat it, you will find a gas coming out at the end of the tube, that will burn with a yellow smoky flame. After all the gas comes off you will find in the bottom of the test-tube a chunk of dry, porous coke. These, then, are the two main products of the destructive distillation of coal. But if you are a born chemist, with an eye to by-products, you will notice along the middle of the tube, where it is neither too hot nor too cold, some dirty drops of water and some black, sticky stuff. If you are just an ordinary person you won't pay any attention to this, because there is only a little of it, and because what you are after is the coke and gas. You regard the nasty smelly mess that comes in between as merely a nuisance, because it clogs up and spoils your nice clean tube.

Now, that is the way the gas-makers and coke-makers—being for the most part ordinary persons, and not born chemists—used to regard the water and tar that got into their pipes. They washed it out so as to have the gas clean, and then ran it into the creek. But the neighbours—especially those who fished in the stream below the gas-works—made a fuss about spoiling the water, so that the gas-men gave away the tar to the boys for bonfires or sold it for roofing. But this same tar, which for a hundred years was thrown away, and nearly half of which is thrown away yet in the United States, turns out to be one of the most useful things in the world. It is one of the strategic points in war and commerce. It wounds and heals. It supplies munitions and medicines. It is like the magic purse of Fortunatus, from which everything wished for could be drawn. The chemist puts his hand into the black mass and draws out all the colours of the rainbow. This evil-smelling substance beats the rose in the production of perfume, and surpasses the honeycomb in sweetness.

It is interesting to recall that anæsthetics like novocaine and stovaine are derived from coal-tar; antipyretics like aspirin, acetanilid, and acetphenetedin; specifics such as adrenaline prescribed for Addison's disease, soamin and arsacetin for sleeping sickness, salvarsan for blood disease, and phenolphthalein used as a laxative. Saccharin, dulcin, and other sweeteners are obtained from the same source; essences like cinnamon and coumarin; photographic developers of various kinds; lyddite, melinite, and trinitrotoluol (called TNT for short), which did such destructive work on the battle-front in Europe. So diverse are the products that it seems incomprehensible that all can be found in one original product.

In the distillation of coal-tar we obtain from the light oil such products as benzol, toluol, xylol, pyridine, phenol, and cresol. From the middle oil we get naphthalene, and from the heavy oil comes anthracene. The refined tar and the pitch left as a residue have their uses. Great industries have been built upon each and every one of these remarkable products, and the chemists have only begun their work in this line. The future is full of possibilities.

Royalty and the Royal Society

By Philip D. Rogers

The recent election of H.R.H. The Prince of Wales to the Fellowship of the Royal Society affords a fitting opportunity to recall the relationship which has always existed between the Throne and that eminent scientific body; a relationship which now dates back for nearly 260 years.

Owing to the fact that so many of the present generation have, in their youthful studies, been nourished on Macaulay, it is not altogether surprising to find that most of them are content to accept without demur the numerous political and personal calumnies which have been heaped upon the heads of the Royal House of Stuart. Without wishing to embark upon any historical controversy, let it be said at the outset that King Charles II, in founding the Royal Society, performed an act the far-reaching results of which might well commend him to posterity as a second Solomon. Writing in 1667, Spratt says of the founding and patronage of the Society by the King: "An enterprise equal to the most renowned actions of the best Princes. For, to increase the powers of mankind, and to free them from the bondage of errors, is a greater glory than to enlarge empires, or to put chains on the necks of conquered nations." The Charter of Incorporation is dated July 1662, and in the April of the following year, a second Charter granting further privileges passed the Great Seal. A third Charter was granted in 1669, but it is by that of 1663 that the Society has since been governed. The King continued to take a deep interest in the progress and welfare of his new foundation, an interest which was shared by his brother, James, Duke of York, and by his cousin, Prince Rupert; the latter, though best known as the dashing leader of the Royalist Cavalry during the Civil War, was also distinguished for his interest in Science, and for his service to Art by introducing into England mezzotint engraving, a process he had learnt directly from the inventor, L. von Siegen.

In 1663 a warrant was issued authorising the delivery of "one guilt mace, being a gifte from His Maiestie." This mace was for many years believed to be identical with the famous "bauble" so rudely dealt with by Cromwell, but the discovery, in 1846, of the original warrant mentioned above finally dispelled this belief. An engraving of the Society's mace, however, actually appeared as an illustration in Scott's *Woodstock*,[1] accompanied by a statement that it represented the "bauble mace" belonging to the Long Parliament. King Charles also granted to the Society very honourable Armorial Bearings, which are described in the second Charter as follows: "These following blazons of honour, that is to say, in the dexter corner of a silver shield our three Lions of England, and for Crest a helm adorned with a crown studded with florets, surmounted by an eagle of proper colour holding in one foot a shield charged with our lions; to be borne, exhibited, and possessed for ever."[2]

In the Society's Charter Book, a superbly emblazoned volume bound in crimson velvet, with gold clasps and corners, the first three signatures are—CHARLES R., Founder,—JAMES, Fellow,—RUPERT, Fellow. In connection with this historic tone the following entry was made by Samuel Pepys in his *Diary* under the date January 9, 1665: "I saw the Royal Society bring their new book wherein is nobly writ their Charter and Laws, and comes to be signed by the Duke[3] as a Fellow; and all the Fellows hands are to be entered there, and lie as a Monument; and the King hath put his with the word Founder." In

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[1] Abbotsford Edition of *The Waverley Novels*.

[2] Translated from the original Latin.

[3] James, Duke of York, afterwards King James II.

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passing it may be mentioned that the famous Diarist was President of the Society for two years, from 1684 to 1686.

At one of the early meetings of the Society a poisoned dagger, sent by His Majesty, was laid before the Fellows; it had originally been received by the King from the East Indies. "The dagger was warmed, and with it blood was drawn from a kitten, to see whether it would be killed thereby. The kitten not dying while the Society were together, the operator was appointed to observe what should become of it." At the meeting in the following week, however, the kitten was produced alive—a sound testimony to the feline legend of nine lives! Incidentally it is interesting to note this experiment as one of the early forerunners of vivisection.

The records of the Society contain several references to their Royal founder, witnessing his continued interest in the progress of Science. It is related that the King ordered Sir Robert Gourdon to send the Society a recipe to cure hydrophobia, invented by his physician, Thomas Frasier; this recipe, needless to say, is very typical of the medical science of the seventeenth century, and consists *inter alia* of roots, leaves, crabs' claws, milk, and Venetian treacle; a truly alarming compound!

The long reign of King Charles II terminated in the year 1685, and his name will ever be honourably associated with the Royal Society, as their Founder and first Patron. No efforts appear to have been made, however, to obtain the patronage of his brother and successor, James II, although, as mentioned above, he was already a Fellow of the Society. William III and Mary, too, do not seem to have taken any active interest in the progress of their predecessor's foundation; their names, together with that of Queen Anne, constitute the only three omissions from an otherwise unbroken chain of royal signatures from 1662 down to the present day. In 1705 Queen Anne was petitioned by the President, Council and Fellows for a grant of land "to build a place of their own to meet in nearer to Westminster"—a petition to which she made no response. Nevertheless, seven years later, she was pleased to intimate her intention of countenancing and encouraging the studies of the Society. This she proposed to do by instructing her Ministers and Governors abroad to promote the Society's interests "by corresponding with the Fellows and procuring answers to such enquiries on scientific matters as may be sent to them from time to time in their several stations." The Queen's husband, Prince George of Denmark, was elected a Fellow in 1704, and the Council desired the President and Secretary to wait on the Prince with the Charter Book, "to have the honour of his subscription." Prince George also munificently undertook to bear the cost of publication by the Society of Flamsteed's *Historia Coelestis Britannica*; this had previously been estimated at between eight and nine hundred pounds.

The First George of England and Hanover, after having conferred his patronage on the Society by signing the Charter Book, was petitioned in 1724 by the President, Council and Fellows to grant a licence to purchase or hold lands, manors, tenements, etc., in Mortmain. This Petition, which was signed by Sir Isaac Newton as President, was referred to the Attorney-General to consider and report upon, and, in consequence of his favourable verdict, was duly granted by His Majesty.

In 1727 the President, Sir Hans Sloane, proposed that an address of loyalty should be presented to King George II, and after several long discussions this address was drawn up; it included also a humble petition for the Royal protection and patronage. A deputation consisting of the President, the Duke of Richmond, and other Members of Council, conveyed it to the King, and it is recorded that "His Majesty was pleased to receive the gentlemen in a most gracious manner, and did the Society the honour to write his Royal name in the Charter Book as their Patron; and that upon waiting on the Queen with a compliment, Her Majesty had likewise been pleased to receive them very graciously."

A similar loyal address was presented to King George III shortly after his accession in 1760, and was conveyed by a deputation consisting of several of the Fellows headed by the President, the Earl of Macclesfield, who relates that "The King was pleased to receive them very graciously—all the Members had the honour of kissing his hand; and His Majesty afterwards sent for the President into his closet, and signed his Royal name in the Charter Book, and was pleased to express a great regard for the good of the Society." The notable progress made by the Royal Society during his reign affords ample evidence of this regard. Shortly afterwards the Dukes of York and Cumberland were elected Fellows. It is pleasant to note that the King's interest was before long evinced in a very substantial form when, in response to a humble request for funds to send out expeditions to distant stations to observe the forthcoming Transit of Venus (1769), His Majesty at once directed that a sum of £4,000 should be paid from the Treasury for this purpose. Three parties were eventually sent out, one to Hudson's Bay, one to Madras, and one to the Pacific; in command of the last-named party was Lieutenant James Cook, afterwards, of course, the famous navigator; on this occasion he hoisted his pennant in the *Endeavour*. Several years after these expeditions had been successfully carried out, a deputation of the Council, headed by their President, Sir John Pringle, waited on the King humbly to express their most grateful thanks for his benefaction; His Majesty received them most graciously, and conferred the distinction of knighthood on James Burrow, the late President.

In the year 1777 a heated discussion concerning the relative merits of pointed and blunt lightning conductors, which had originated in the scientific world, developed into a controversy of considerable political importance, and, for the first and last time in its history, the Royal Society—or rather its President—was brought into direct opposition with the Throne. The King, having for political reasons adopted the blunt form of conductor on his palaces, endeavoured to make the Society rescind its resolution in favour of the pointed variety, and in an interview with Sir John Pringle urged him to use his influence in support of the Royal wish. The President, however, replied to the effect that, although duty would always induce him to carry out His Majesty's wishes to the utmost of his power, he was unable to reverse the laws of nature. Whereupon King George is said to have replied, "Then, perhaps, Sir John, you had better resign"; and at the following anniversary Sir John resigned the presidency, though Dr. Kippis, his biographer and intimate friend, denies that his resignation was due to this cause.

Science in general, and the Society in particular, suffered a heavy loss in the death of George III at the beginning of the year 1820; his reign—one of the longest and most illustrious in our history—marked an epoch greatly enlightened by the accomplishments of many famous scientific men.

Shortly after the accession of King George IV the customary address of loyalty to the Sovereign was presented, and it is recorded that His Majesty was graciously pleased to become the Patron of the Society. Within the first few months of his reign he issued a Royal Warrant appointing the President and certain of the Fellows to be Visitors of his Royal Observatory at Greenwich. In 1825 the President—Sir Humphrey Davy—received a communication from Sir Robert Peel intimating that the King proposed to found two gold medals of the value of fifty guineas each for the most important discoveries, or series of investigations, completed to the satisfaction of the Society within the five years preceding the award. The Council thereupon resolved "that the offer contained in this letter be most gratefully accepted, and that the humble and dutiful thanks of the President and Council be respectfully returned to His Majesty for this instance of his munificence, and of his disposition to promote the objects of the Royal Society, and the general interests of Science." These medals were known as

[*Continued on p. 92*

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the Royal Medals, and bore on the obverse the effigy of the King, and on the reverse the statue of Newton in Trinity College Chapel, Cambridge; they are still awarded annually, the names of the proposed recipients being submitted to the Sovereign for approval before they are finally awarded.

On the death of George IV in 1830, his brother, the Duke of Clarence, succeeded to the throne as King William IV, and to him the Society forthwith tendered its loyal address. The new King immediately consented to become the Patron of the Society, and, having signed the Charter Book on a page especially illuminated for him, declared that "he would be proud to take every opportunity of promoting the interests of an Institution, whose great object is the cultivation of science and the discovery of truth." In 1833 the King signified his intention of restoring the foundation of the Royal Medals, which had been in abeyance during the three preceding years, and for this purpose he sent the Society a set of revised regulations governing the award of these medals. For a period of eight years just covering the reign of William IV the Society had the great honour of a very close connection with the Throne, its deliberations being presided over by a Prince of the Blood Royal. At the Anniversary Meeting in 1830, H.R.H. The Duke of Sussex, sixth son of King George III, was elected President, and continued to hold this office until 1838. Throughout this time the Duke guided the proceedings of the Society with an energy and zeal fully characteristic of the generous interest which had always been shown towards scientific matters by his House.

On the death of her uncle, Queen Victoria graciously signified her intention of becoming the Patron of the Society, and approved the continuation of the annual grant of the Royal Medals. The Prince Consort was elected a Fellow in 1840, and Edward, Prince of Wales, in 1863; the latter became Patron of the Society on his accession in 1901. His present Majesty was elected when Duke of York in 1893, and was formally admitted in 1902, when Prince of Wales. He also at his accession graciously consented to become Patron of the Society.

Other Royal Fellows of recent years include H.R.H. The Duke of Connaught, elected in 1906, and his son Prince Arthur, who became a Fellow in that most momentous year of the Empire's history, *anno belli* 1914.

The Royal Society has a membership at present of about four hundred and sixty members. Each year in May fifteen new Fellows are elected from about a hundred candidates. Fellowship of the Royal Society is one of the highest honours that can be given to a scientist.

Reviews of Books

The Art of the Greek Vase Painter: a Handbook of Greek Vase Painting. By MARY A. B. HERFORD, M.A. (Manchester University Press, 9*s.* 6*d.* net.)

More patient research has perhaps been expended in recent years on the fascinating study of Greek Vase Painting than on any other branch of ancient archæology; and so fruitful have these investigations proved, and so positive in their results, that the time has come when the student should no longer be obliged to collect his information from articles scattered about in learned periodicals or the descriptions of museum catalogues. In Mr. H. B. Walters' *History of Ancient Pottery* we have, it is true, an excellent manual of a wider scope; but a compact handbook dealing with the narrower subject of Greek Vase Painting has been a desideratum both of the archæological student and of the general reader.

It is to the former rather than to the latter that Miss Herford's book will appeal. We are inclined to think that the general reader, who approached the subject with no previous knowledge of this or any other branch of ancient art, would find too much discussion of technical questions, and too little stress on the æsthetic and human side. Miss Herford's interest is primarily in the technical side, and her account of this is exactly what the student has long required.

Part I of the Handbook deals with the technique of the Greek vase and the status of the potter (it is interesting to note that after the Peloponnesian War the wages of the craftsman were 100 per cent. higher than before), the shapes, and the use of vases. Part II (Historical) deals with the evolution of the art of vase-painting in Greek lands and Italy. The treatment of the earlier period appears to be more adequate than that of the later, particularly of the South Italian wares. It may be regretted that additional chapters were not devoted to discussing the light thrown by Greek vase paintings on contemporary life and literature and on mythology; also that the numerous references enclosed in brackets in the text were not relegated to the bottom of the pages.

The illustrations, which are necessarily restricted in number, are well chosen and include a number of interesting vases which have never been published before. It is obvious, however, that the student will require frequently to refer to the catalogues of the great collections to which Miss Herford gives frequent references.

Miss Herford's book is certainly one which adequately fills a gap in the library of the archæological student. To all those who are interested in the progress of the new Universities it must be a matter of gratification that such a book as this should have been produced by an archæologist trained in the University of Manchester, and the daughter of one of its most distinguished professors.

The form and printing of the volume are admirable.

E. S. F.

Russia in Rule and Misrule: a Short History. By BRIG.-GEN. C. R. BALLARD. (John Murray, 6*s.* net.)

General Ballard has taken on a job similar to that of the Scottish probationer who announced from his pulpit, one Sunday morning, that he was going to preach on the subject, "God, Man, and the Universe," and would devote ten minutes of his time to each. The probationer was a trier, who believed in compression; and very probably his sermon was an excellent one.

The author of this book has been successful in his task, the heavy task of giving a clear and interesting account of the chief events in the history of Russia, from the earliest times to the events of 1918, in a book of about two hundred pages. His sources of information are entirely Russian, drawn from the standard histories, from newspapers and pamphlets, and from personal talk with Russians during the war years, so that we get a point of view expressed which is missing in many histories and accounts of Russia.

The larger portion of the book is devoted to the events of the past twenty years, the troublous time of the late Tsar, the Russo-Japanese War, the Great War, the revolutionary movement, and the doings and misdeeds of the Bolsheviks. Very interesting is the description of how King Edward, by his tact and kindness, improved the strained relations between Russia and ourselves after the Japanese War. It is also pointed out what a tragedy for Russia, as well as for ourselves, was the loss of Lord Kitchener in the *Hampshire*. In the description of the war and the revolutionary movement the author is writing with first-hand knowledge, and one feels that an accurate account is being given of much that has hitherto been uncertain.

The book is a plea for a sane interest in Russia. It emphasises the fact that Russia is not just a political problem, a country we praise to the heights one year, and curse to the depths the next, but a country of Europe with a language worth knowing, and a literature worth reading, and a history and geography worth studying—a big country in every way, whose present situation and future possibilities deserve the attention of thinking men. P. K. F.

Poetry and Commonplace. By JOHN BAILEY. (Oxford University Press, for British Academy, 1s. 6*d*. net.)

This is a quiet and pleasant essay, delivered to the British Academy on November 26, 1919, on the relation of poetry to commonplace, using this word not in the bad sense of what is "trite" and "obvious," but in the better sense of "a great saying of universal application." If poetry be granted to deal, above everything else, with truth, then it must of course deal with things which are most universal, which is precisely the stuff of commonplace. The essayist points out that the greatest poets are concerned not so much with creating new ideas, and inventing new ways of expressing themselves, as in making poetry out of the things of ordinary life, and out of truth which is old and known. They have, of course, the power of invention, but side by side with this, and of greater importance, is their power of rediscovery. By rediscovery is meant not a new emphasis of the obvious, or an expatiation on a theme with which everybody is familiar, but something which makes us see new truth and new beauty in old things, and makes us not merely know these things, but have that perception of them which Wordsworth called "the breath and finer spirit of all knowledge." This relation of poetry to commonplace is illustrated by examples from several of the great poets, especially by examples from Wordsworth. Says the essayist, "He [Wordsworth] lives to-day less by his original creative side, the side of discovery as I called it, than by his singular genius for rediscovery, by his gift for making the dry bones of all sorts of commonplace live, the commonplaces of life, of language, and of thought"; and again, "the essential business of Wordsworth was to make a primrose by a river's brim more than that to everyone who reads: to bring out the strangeness of the common, the interestingness and newness and significance of the commonplace."

The poetry of the Psalms, of Homer, Horace, Gray, Meredith, Tennyson, and, coming to our own day, of Mr. de la Mare, furnishes the essayist with further illustrations of his theme. P. K. F.

[*Continued on p.* 94

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Springtime and other Essays. By SIR FRANCIS DARWIN, F.R.S. (John Murray, 7*s.* 6*d.* net.)

The happy title has much to do with the book's finding favour in our eyes. What it suggests of life and freshness is fulfilled in the table of contents—a procession, if we may borrow the author's word, of delights, the mere reading of which perhaps leads us to expect too much. Such magic words as "Dickens' Letters," "Recollections," "Instruments of Music," "Traditional names of English Plants," make us turn over the leaves with eagerness. A slight feeling of disappointment is inevitable when we realise that the treatment of these charming subjects is somewhat light and superficial.

It is true that the botanist teaches us much, and his flower cycles and name-stories are valuable as well as beautiful additions to our knowledge of plant life; but many of our old literary favourites are condemned in his less happy essay on "Names of Characters in Fiction."

The review essays are well done and condense long biographies for us, giving admirable pictures of their subjects and wise selections of their writings and *bons mots*. It is an ideal book for the poet's "Shady Nook."

M. R.

An Amazing Séance and an Exposure. By S. A. MOSELEY. (Sampson Low, 3*s.* net.)

It is difficult to realise what good purpose is served by the publication of this little book.

It is the work of a journalist who evidently has written up his experiences in a great hurry. The author's purpose is to present a straightforward record of an independent investigation into the claims of spiritualism. He attended many séances, and he had many curious experiences. He became, as a result, a convinced spiritualist.

We hold the conservative view that the investigation of spiritualistic phenomena is best done by men trained in pathology, psychology, and in conjuring. The opinions of men who have had no opportunity of special training, however honest and *bona fide* they may be, cannot be considered of any value.

A little less ingenuous credulity and a development of the critical faculty would assist things enormously. For example, a man who goes to séances and gets his ears boxed and has another person's braces deposited in his lap should insist on having the gas lighted. (We don't pretend to any originality in making this suggestion, but it is a helpful one). The presence of a material thing like light would help material people like ourselves enormously, and should have no effect on a spirit, and it would certainly lead to less involved explanations of the things that occur.

Electric Spark Ignition. By J. D. MORGAN. (Crosby Lockwood, 8*s.* 6*d.* net.)

Jane's Pocket Aeronautical Dictionary. (Sampson Low, 1*s.* 6*d.* net.)

Mr. Morgan gives an account in this little book of the scientific basis of the subject of electric spark ignition in internal combustion engines. It is of interest and use to the people for whom the compilation of information has been made, namely designers and students working on the subject of petrol-engines. At the end of each chapter references to further information on the subject dealt with are given.

The *Aeronautical Dictionary* is a useful book to anyone who wishes to know the meaning of technical and slang terms used in connection with aircraft.

The Turks in Europe. By W. E. D. ALLEN. (John Murray, 10*s.* 6*d.* net.)

To read of the arrival of the Turks into Europe as the coming of an obscure tribe of nomad *shepherds* may be a revelation to many of us. But such they were, and Mr. Allen has given us a most concise history, from the thirteenth century to the year of the outbreak of the war. It is more than a history. It is an interpretation, and one may read it as easily as a romance—but a romance over which falls the shadow of the sword.

The story consists chiefly of the record of fighting, pillage, murder, and violence, yet the author has made the Turks interesting and even understandable.

After reading the book, the enigmatical mentality of the Turks seems nearer a solution, and we understand why, although he has been in Europe so long, the Turk has never been of Europe.

The future of Turkey and of the Turks is one of the most important problems that the result of the war has set our statesmen, yet most of us know very little of this race. We should thus especially welcome Mr. Allen's book.

M. R.

OTHER PUBLICATIONS RECEIVED

(We hope to deal with several of these in future issues.)

Instincts of the Herd in Peace and War. By W. TROTTER. (Fisher Unwin, 8*s.* 6*d.* net.)

An Introduction to Physics. By R. A. HOUSTOUN. (Longmans, 6*s.* net.)

Heredity. By J. ARTHUR THOMSON, 3rd Edition. (John Murray, 15*s.* net.)

Streamline Kite Balloons. By CAPT. P. H. SUMNER, R.A.F. (Crosby Lockwood, 10*s.* 6*d.* net.)

Studies in Mental Inefficiency. Vol. i, No. 1. (The Central Association for the Care of the Mentally Defective, 9*d.* net.)

Religion and Culture. By FREDERICK SCHLEITER, Ph.D. (Columbia University Press; London: Milford, 8*s.* 6*d.* net.)

Meteorology for All. By D. W. HORNER. (Witherby, 6*s.* net.)

The Practical Book of Interior Decorating. By H. D. EBERLEIN, A. MCCLURE, and E. S. HOLLOWAY. (Lippincott, 35*s.* net.)

The Quantitative Method in Biology. By PROF. JULIUS MACLEOD. (Manchester University Press, 15*s.* net.)

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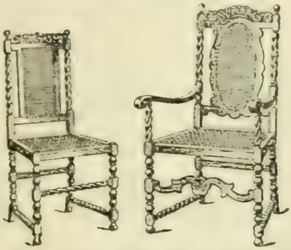

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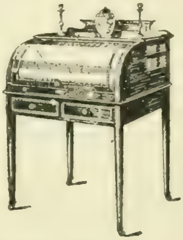

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ABBREVIATED REPORT OF CHAIRMAN'S SPEECH

AT

ANNUAL GENERAL MEETING, HELD AT THE SAVOY HOTEL, ON WEDNESDAY, MARCH 31ST, 1920, AT 12.30 P.M.

I HAVE much pleasure in moving that the Directors' Report and the Balance Sheet to the 31st December, 1919 (which have been in your hands for some days), and the Directors' recommendations as to the appropriation of the Profits be and the same are hereby adopted.

It is nearly four years ago since I first had the pleasure of meeting you, and I then had a very unpleasant task. Our circumstances were then not very brilliant and we had considerable leeway to make up, but I told you not to lose hope but to be of good cheer and to have faith in your Directors. You were good enough to have and to show that faith, and it is a source of great gratification to me and to all your Directors that your faith in us has been abundantly justified.

The Balance Sheet we present to you to-day is the finest ever issued by the Company. We propose to pay you the substantial dividend of Fifteen per cent. for the year, to transfer £20,000 to the Reserve Fund, to write £19,311 off the Goodwill, and to carry forward to next year the sum of £26,683. This splendid result has been arrived at by the combined efforts of all our establishments in London, Sheffield, Paris, Rome, Nice, Lausanne, Johannesburg, Buenos Aires, Rio de Janeiro, Sao Paulo, and Montreal.

Our Sales and our Profits during the year 1919 exceeded all records, and we are yet far from the limits of our expansion. The higher prices now prevailing for goods accounts, to some extent, for our increase in Sales, but, making every possible allowance under this head, our Sales for the year 1919 were more than double the amount of our Sales in any year before the war.

Last year I ventured to predict that for the next four or five years the trade of this country would be phenomenal. My prediction has proved to be correct. South-east Lancashire, Huddersfield, Bradford, Birmingham, Glasgow, Belfast, Nottingham, and Sheffield are overwhelmed with orders. In our own factory in Sheffield we have at this moment two years' work on hand. For some years our Royal Works at Sheffield were able to produce all the goods we required, but in recent years its output has been wholly inadequate to supply our rapidly expanding trade. We have, therefore, acquired in Queen's Road, Sheffield, a large plot of land, and on this site we are building what I should hope will be one of the most modern and efficient factories in this country and which will have an output double the capacity of the Royal Works. In this new factory we are carefully studying the comfort and convenience of our workpeople. The day has long passed when these matters can be neglected. We also propose to almost immediately rebuild the premises we have recently acquired in Oxford Street. When these rebuilding operations are carried out we shall have one of the most magnificent shops in London.

Under strong pressure we opened, a few months ago, a shop in Monte Carlo. It will please you to hear that this, our latest development, is doing exceedingly well. I believe in Monte Carlo we have one of the finest exhibitions of English goods in that part of the world.

The Goodwill now stands at £149,311, a reduction of £10,000 compared with 1918. If you approve the recommendations we make, this will be at once reduced to £130,000. I may mention, incidentally, that our Goodwill could be sold in twenty-four hours for double the amount it stands at in the Balance Sheet, but we have decided, nevertheless, to extinguish the item.

When this Company was formed by the late Mr. John Newton Mappin, I do not think that he, or any of his colleagues, dreamt that it would ever reach its present dimensions.

The result is that we find ourselves bound by some regulations which are altogether unsuited to our present condition. One of these relates to our borrowing powers. By the Articles of Association they are limited to £400,000, and as £250,000 have been raised on Debentures, there remains a margin of only £150,000. This is utterly inadequate. To cope with our enormously extended and extending business, to buy the land we have acquired in London and Sheffield, to extend our business in Canada and Monte Carlo, and to acquire subsidiary businesses, we have been compelled to borrow and to borrow in excess of the limit imposed upon us; this you can readily infer from the increase in the amount of our Creditors during the year by no less than £231,257.

In the course of this Meeting, therefore, I intend to move that our borrowing powers be raised from £400,000 to £750,000—a motion which I hope will gain your approval.

You will naturally ask how we intend to raise the additional money contemplated.

In the first instance we will borrow it, but ultimately, I think, it will take the form of an issue of shares to the Shareholders on favourable terms for a part of it. The other part must be repaid by yearly instalments out of profits.

As long as I am Chairman of this Company I am determined that our finances shall be conservatively handled, that our Capital shall be kept as low as possible, and that a substantial part of the funds for our expansion shall come out of profits.

I hope you will agree with me. By such a course we keep our Company financially sound and improve the value of our Shares year by year.

We have had a wonderful year, and your Directors face the future with serenity. We have three factors which tell for success in the business. We have a splendid name, a name standing everywhere for good workmanship and good faith. We have a good reputation in the City of London; we have an even greater reputation in the great City of New York. We have a loyal and contented and a skilful staff. And, lastly, you have a united, a harmonious, and, I hope you will think, an efficient Board.

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Editorial Notes

A clear, uncoloured statement of what commercial aircraft can and cannot do has been recently given by Mr. Holt Thomas, and deserves attention. On the whole the prevailing opinion with regard to the commercial possibilities of aircraft is pessimistic. Yet during the war it looked sometimes as though aircraft were going to be everything in the future. Mr. Thomas's view lies between these extremes. He recognises that in this country the aeroplane cannot compete at present with existing forms of transport, but it may supplement them. It can with advantage carry mails, parcels, and passengers on urgent business, when part of the journey as ordinarily accomplished is over the sea. Thus an aeroplane can compete with train and boat in a journey from London to Paris or to Cork or Dublin, but not to Manchester or Edinburgh. The aeroplane travels, of course, twice as quickly as a train, but there is time lost in getting to and from the aerodromes at both ends, which reduces the overall speed of the journey considerably. Moreover, trains can, and aeroplanes usually do not, travel at night. In addition to all this there is the weather. Fog is the great nuisance in flying. Wind may help or hinder speed, but fog makes the pilot blind. Some kind of reliability of service is necessary before the business man will trust his messages or himself to the aeroplane. Yet, though we cannot abolish bad weather, we can partially conquer it by suitable organisation; and this is discussed.

Mr. Holt Thomas thinks that pleasure flying will never be very popular. It is too tedious, too uninteresting. Joy-rides in France seemed great fun. Does one become blasé after a bit? It seems so. One hears of owners selling their aeroplanes because flying bored them.

* * * * *

A very interesting account of a journey in an unknown part of Arabia, Southern Najd, is given by Mr. Philby, of the Indian Civil Service, in the March number of *The Geographical Journal*. Mr. Philby is an authority on Arabia. He is the only living European who has crossed the peninsula from the Persian Gulf to the Red Sea. This account does not deal with this big journey, but with an "excursion" of three hundred miles out and three hundred home through a dangerous part of the country. From surveys made by Mr. Philby a map of this part of Arabia has been made. The account of a journey made by Palgrave, an Englishman, into Central Arabia in 1862 is criticised. Part of this man's account seems to be inaccurate, part purely imaginative.

* * * * *

Quite recently an account has been given of a new way of making soap. Clay in the "colloidal form," when suitably prepared, may be satisfactorily substituted for a large proportion (up to about 50 per cent.) of the fatty acids in soap. (Matter may roughly be said to be in the "colloidal form" when it is in an extremely fine state of subdivision.) As clay is cheap, and soap relatively dear, the substitution of clay in this form for the fatty acids produces a notable reduction in cost. The clay is a real substitute for soap, and not an adulterant. Hot solutions of colloidal-clay soap form jellies on cooling, and thus this soap not only resembles ordinary soap in appearance, but in cleansing properties it is said to be even better than pure soap. Developments of this interesting discovery will be awaited with interest.

Mention was made in Mr. Darwin's article, in the second number, of the work of Mr. Aston at Cambridge on the purity of chemical elements. Mr. Aston first showed that the gaseous element neon is really composed of two gases the atomic weights of which are 20 and 22. He also showed that "pure" chlorine really consists of two gases of atomic weights 35 and 37. Nitrogen (atomic weight 14) and Carbon (atomic weight 12) appear to be "perfectly pure"—that is to say, *not* a mixture of two or more elements of almost identical properties, as are neon and chlorine. He has extended his results recently to other elements. Argon is found to consist of two gases of atomic weights 36 and 40; krypton of six gases, xenon of five gases, and mercury of a mixture of elements of atomic weights 204, 202 certainly, and of others about 197 to 200 in atomic weight. Helium (atomic weight 4) is found to be "perfectly pure." These results will be of extraordinary interest to all students of natural science. That a chemical element in its purest form should, all the time, be really a mixture of elements, which no *ordinary* chemical or physical process can separate, is a matter of great importance. In all cases which Mr. Aston has so far investigated, with the single exception of hydrogen, the atomic weights of these constituent elements, the "isotopes," are whole numbers.

* * * * *

The great interest of Einstein's General Theory of Relativity may justify a brief note about his career. The following details were kindly supplied by Dr. E. Freundlich. Albert Einstein was born in March 1879, in Ulm in Würtemberg. His school years were spent in Munich. He early showed promise of an unusually brilliant future. He studied physics and mathematics at Zürich University from 1896 to 1900. On attaining his majority he changed his nationality by becoming a citizen of Zürich. During the next seven years he was engineer to the Patent Office, Bern. His first great achievement, the special Theory of Relativity, was enunciated in a paper read to the Berlin Academy of Sciences. It was soon followed by others dealing successively with the inertia of all forms of energy, the Brownian movement, and the Quantum Law of the emission and absorption of light. He became Professor Extraordinarius at Zürich in 1910, and later full professor at Prague, but returned to a permanent post in Zürich in the following year. The fundamental notions of his epoch-making theory, which has undermined the traditional conception of space, were evolved in 1907; but his attempts to solve the elusive problem of gravitation only began to show signs of success in 1912, when he recognised how much more simply gravitational phenomena could be interpreted by adopting non-Euclidean space. In 1914 he migrated to Berlin, where he has since remained. His general theory of relativity was made known to the Berlin Academy of Sciences in 1915, when he established the equations of the gravitational field, and succeeded in explaining mathematically the behaviour of the motion of Mercury's perihelion, which had long been a source of mystery to astronomers.

In addition to his scientific attainments, he is deeply devoted to the Zionist cause, and is a keen internationalist. He is also an accomplished violinist. During the war several of our men interned in Berlin found in him a good friend.

The Date of the Nativity

By W. M. Calder, M.A.

Professor of Greek in the University of Manchester.

It is well known that Christ was born some years before the date of the "Birth of Christ," which forms the starting-point of the Christian Era.[1] Luke in all probability intended to imply, and Matthew definitely states, that Christ was born before the death of King Herod, who ordered the "Massacre of the Innocents"; and we know for certain that King Herod died early in 4 B.C. Recent discovery—or discovery which would have been called "recent" in 1914—has thrown fresh light on the events which, in Luke's narrative, form the setting of the birth of Christ. We cannot yet assign the Nativity to a definite year, but many old difficulties have been cleared away, and the choice of a possible date has been restricted within narrow limits. At the invitation of the Editor, I will attempt to indicate briefly the character of the problem, and the bearing of the new evidence on its solution.

The words of Luke are as follows (ch. ii. 1–4): "Now it came to pass in those days, there went out a decree from Cæsar Augustus that all the [Roman] world should be enrolled. This was the first enrolment, made when Quirinius was governing Syria. And all went to enrol themselves, every one to his own city. And Joseph also went up from Galilee, out of the city of Nazareth, into Judæa, to the city of David, which is called Bethlehem, because he was of the house and family of David—to enrol himself with Mary his wife, etc." And thus it came about that the child of Nazarene parents was born in Bethlehem.

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[1] How this traditional date was arrived at in the third and fourth centuries A.D. does not concern us here. Information on the matter may be sought under the articles Eusebius and Jerome in the *Encyclopædia Britannica* (ed. xi).

This passage from Luke contains statements bearing on Roman Imperial administration, which at one time excited the surprise and moved the suspicion of historians. Mommsen, the greatest of nineteenth-century historians of the Roman Empire, writing in 1883,[1] went carefully into the literary and archæological evidence available at that date, and came to the conclusion that Luke must have grouped events belonging to different periods into a single year, and could not be writing accurate history. He concluded in particular that Quirinius could not have governed Syria before the death of Herod. Luke, as a matter of fact, does not state definitely that Christ was born before Herod's death, but Matthew does, and I personally accept the common view that Luke intends to imply it. Mommsen's opinion was almost canonical in matters of Roman history; and its effect may be measured by the fact that two learned and conservative writers in Hastings' *Dictionary of the Bible* (1900), one of them a first-rate authority on early Christian chronology, admit that, in his dating of the birth of Christ, Luke has been convicted of error. Other scholars took the opposite view, and new discovery has proved them right.

Combining Luke's narrative with the story as told by Matthew, we find four distinct statements which the Roman historian can test in the light of his knowledge of early Imperial administration.

1. That Christ was born in the reign of Herod (who died early in 4 B.C.).
2. That at the time of Christ's birth, the first census of the Roman Empire was being taken, by order of Augustus.
3. That this census was taken while Quirinius was governing the Roman province of Syria.
4. That to be enrolled, families had to report at a prescribed place, which in the case of Joseph was "his own city."

A number of inscriptions have been found, chiefly in Asia Minor, which bear on the date of Quirinius's governorship of Syria. A number of documents on papyrus have been found in Egypt which give a hint of the probable date of the first institution of the Roman census, and shed much light on its character and purpose. I am concerned here only with the inscriptions, but may refer first, and very briefly, to the papyri.

The papyri prove for Egypt—and their combination with literary evidence makes the same thing highly probable for all the Eastern part, at least, of the Roman Empire—that there was a periodic census, taken every fourteen years. The Roman Government taxed its subjects for the air they breathed, and boys became liable to this poll-tax at the age of fourteen; hence the period. A series of dated census-papers have been found belonging to the years 20, 34, 48, 62 A.D. If we extend the series upwards, we get the years A.D. 6 (when we know, from Acts v. 37, that a census was taken in Palestine) and 8 B.C. The latter year, as we shall see below, may very well be the year of the Nativity; but as the question of the earlier dates, and the local arrangements in connection with the census, is still canvassed by experts, we only lay claim to the presumption that a census, called by Luke "the first," was taken about 9–7 B.C.

The papyri also show that the census authorities ordered everyone to return to his city or village to be enrolled. Luke's statement regarding Joseph and Mary is an interesting record of an early and partial application of that principle of Roman Law which, in a later development, forbade certain classes to leave their home, tied the cultivator to the soil, and evolved the serf of mediæval Europe. But this is to travel beyond our subject.

Let us turn now to the inscriptions and the events with which they were concerned.

The mountainous country in the south of Asia Minor was notorious throughout the last century of the Roman Republic as a nest of pirates and brigands. In 102 the Romans annexed the plain of Cilicia, which formed a convenient base of operations against the pirates on the sea and the clans in the mountains. We read of more than one attempt to subdue the Taurus tribes, the most considerable being the campaign of Servilius Isauricus in 78–74 B.C., and the famous war of Pompey against the pirates in 66. In 63, Pompey annexed Syria to Rome; and Cilicia and Syria became a single army-command. The army in Syria had the double task of guarding the Euphrates frontier against the Parthians, and controlling the tribes that dwelt in the mountains to the north and north-west of Cilicia. To this responsible duty four legions were assigned; and this army we know to have been the only body of "regular troops" in the Asiatic provinces during the reign of Augustus. The Syrian legions were under the command of the governor of Syria, who, by the rules of the service, was required to have held the consulship (and usually had considerable experience of other provincial commands) before he became governor of Syria.

It is a matter of history that Quirinius (who had already distinguished himself as a soldier) was consul in 12 B.C. In the ordinary way, a Roman ex-consul who rose to the Syrian command took a round dozen of years to do it. Now, it is known that other Roman officials—we have their names and the dates of their tenure of office—governed Syria from 9 B.C. till after Herod's death in 4 B.C. Mommsen argued quite reasonably, on his evidence, that the first governorship of

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[1] In his edition of the *Monumentum Ancyranum*.

Quirinius must be placed not earlier than 3–2 B.C. I say the "first" governorship, because Quirinius actually governed Syria twice, the second time being in A.D. 6, when the census mentioned in Acts v. 37 was taken in Palestine. What, then (so it was argued), would be more natural than that Luke, using a tradition that Christ was born during the taking of a census, while Herod was alive and Quirinius was governing Syria, should have confused the census of A.D. 6 with an earlier group of events, and produced a clumsy combination of two different occurrences, a census under Quirinius and a census in the lifetime of Herod? So it appeared to Mommsen.

The effect of the new evidence has been to bring out the true character of Quirinius's first governorship of Syria, and to prove that this governorship must have been earlier than 6 B.C., and in all probability covered the years 10–7 B.C.

Return now to the tribes on the north-west frontier of the double province of Syria and Cilicia. During the troubled years which intervened between Pompey's organisation of the East and the establishment of the Roman Empire (about 30 B.C.), the Romans attempted to control this region by means of a series of client kings, who were legally vassals of Rome, and were employed to keep the peace, to educate outlying districts in the ways of civilised life, and to train them for eventual absorption in the Roman Empire. One of the most efficient of these client kings was a Galatian called Amyntas, who at the beginning of the empire controlled a large part of the centre of Asia Minor, lying between the Roman territories in the west and north-west and those in the south-east. The main task of Amyntas was to free the road across Asia Minor, and to protect the central plains, from the inroads of the tribes in the southern mountains, and he attacked the tribes among their strongholds, had some successes, but was killed by one of the tribes, the Homanades, in 25 B.C.

Augustus now incorporated the kingdom of Amyntas in the Roman Empire, and undertook direct responsibility for the policing of the southern mountains. The literary tradition contains vague references to a war, fought by Quirinius, which brought peace at last to this turbulent region. The inscriptions, whose discovery extends from 1886 to 1914, illustrate the character of the war, and show that it was over in 6 B.C.

We have seen that Quirinius was consul in 12 B.C. He was a man of humble birth, to whom high office did not come in the ordinary course. Nor was the command of the Syrian legions held, in the ordinary way, immediately after the consulship. Quirinius must have been made consul expressly in order to qualify him for the command of the Syrian legions in the impending war, and his governorship of Syria had the character of a special mission. This is why we find a second governor in Syria at the same date: a governor of the ordinary type was required for the routine civil government of the province while Quirinius led the army on a distant, arduous, and lengthy campaign.

That the war was successful is proved by two pieces of evidence. An inscription now in the Lateran Museum of Christian Antiquities mentions that Quirinius received the Roman equivalent of an Earldom for the subjugation of a people—the name of the people was on a part of the inscription now broken away, but there is no doubt that it was the Homanades, who killed Amyntas, and who were specially aimed at in the campaign of Quirinius. A series of inscriptions, scattered throughout Pisidia, show that in 6 B.C. a number of garrison cities were being founded, guarding all the key positions in Pisidia and the country of the Homanades. These garrison cities were joined by a series of military roads provided with milestones, which give us the date.

Now it is obvious—especially to those who know the forbidding character of the Pisidian country—that those garrison cities could not have been founded, nor those roads built and measured by milestones, until the country was completely subdued. Quirinius's engineers could no more have constructed this elaborate system of roads—one of them through the very heart of the Homanadensian country—before the complete subjugation of the mountain tribes than General Wade could have built his fortresses and roads in the Scottish Highlands before Culloden. In point of fact the Pisidian mountaineers gave no further trouble to the Roman Empire for centuries.

The most recently discovered inscriptions actually mention the name of Quirinius, and show that he held an honorary magistracy in Pisidian Antioch—the G.H.Q. of the campaign—along with the governor of Galatia, in whose province the campaign was fought. This honorary magistracy—whose actual duties were carried out by an officer in Quirinius's army—had the effect of establishing a military dictatorship in Antioch, and was thus an essential step in the campaign. An argument too intricate to repeat here dates this magistracy about 9–7, and probably in 8 B.C. It may be regarded as proved beyond dispute by these inscriptions that Quirinius was fighting in Pisidia during at least two of the years 10–7, and that he was fighting there during his first governorship of Syria.

While Quirinius was fighting in Pisidia, Syria was being administered by an official called Sentius Saturninus, who held office in 8–7 B.C. Various ancient authorities mention Saturninus as the Syrian governor of that period, and Tertullian, a Christian who wrote about A.D. 200, and had access to Roman official sources, tacitly corrects Luke when he says that Christ was born in the governorship of Saturninus, and that Saturninus took the census. Incidentally, we may note that Luke does not say that Quirinius took the census, but only that the census was taken while Quirinius was governor. It was different with the "second census" in A.D. 6, which is stated on an inscription to have been carried out, in Syria, by Quirinius during his (second) governorship. We are justified in concluding that Tertullian was using a good authority when he said that Saturninus took the "first census" in Syria—probably the Roman official lists. Why, then, does Luke date the Nativity by the name of Quirinius, whose governorship we have seen to have been of an exceptional and *ad hoc* character, rather than by the name of the ordinary Roman governor of the year?

Tertullian uses Roman official information, but Luke's story is caught from the lips of people in the East who remembered the events of the last decade before our era. What impressed itself on the memory of the contemporary Syrians and Cilicians was not the name of the humdrum civil governor, but that of the soldier who had fought a brilliant campaign on the North-west Frontier, had broken the power of the Pisidian robber chieftains, and freed the great trunk road along which trade, administration, Græco-Roman culture, and later on Christianity, moved from East to West and West to East.

It thus appears that the birth of Christ must be dated earlier than 6 B.C.; and that several convergent lines of argument point to a date 9–7, and probably 8 B.C.

NOTE.—In this short account many statements have necessarily been made briefly and dogmatically. The reader will get a good idea of the recent growth of knowledge in this subject if he compares the article on Quirinius in Hastings' *Dictionary of the Bible* (vol. iv, 1902), which was out of date before it was printed, with Ramsay's *Was Christ Born in Bethlehem?* (1898), and this again with Ramsay's more recent work, *The Bearing of Recent Discovery*, etc. (1915), chapters xviii to xxi. See also articles by Cheesman and by Ramsay in the *Journal of Roman Studies*, 1913–17. On the principle of law and administration exemplified in the journey of Joseph and Mary to Bethlehem see Zulueta in *Oxford Studies* (Vinogradoff, 1909), and the Russian scholar Rostowzew in his *Studien zur Geschichte des römischen Kolonates*, *passim*.

The Transfusion of Blood

By Geoffrey Keynes, M.D.

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THE idea of the transference of blood from the veins of one person to those of another is one that has always appealed to men's imaginations. It has seemed natural to suppose that the blood, circulating as it does so intimately in a man's body, must carry with it some of the characteristics of its owner. Old men have sought to regain their youth by having transfused into them the blood of boys; soldiers in France have refused even to let their lives be saved by having transfused into them the blood of Germans. It is improbable that transfusion in the ordinary sense was tried before the discovery by Harvey in 1616 of the circulation of the blood, but this discovery must have at once suggested the possibility of the direct transference of the blood from vein to vein, and various attempts were made. It is recorded in Sprat's *History of the Royal Society*, 1667, that Sir Christopher Wren was conducting "many new experiments, and chiefly that of *transfusing blood*, which the *Society* has prosecuted in sundry instances, that will probably end in extraordinary success." Wren's attempts did, however, end in failure, and it has been left to a later age to achieve the "extraordinary success" that was predicted two and a half centuries ago. To-day there are hundreds of men alive who have had the blood of others flowing in their veins, and, indeed, owe their lives to this very fact. But the blood-letting of war had lasted for two years before it became, chiefly through the American doctors in France, a common thing to save men's lives by the direct replacement of the blood which they had lost.

All the earlier attempts to transfuse blood were done by means of a direct flow of blood from an artery in the forearm of the "blood donor" through a tube into a vein in the arm of the recipient; but it was impossible to know how much blood had passed through the tube, and it was very difficult to prevent the blood from clotting in the tube and so blocking the flow of blood completely. An advance was made in 1892, when a method was devised of transferring blood from one person to another by means of a syringe, which was repeatedly filled from the donor's veins and emptied into those of the recipient. By this means the amount of blood could be measured, but the difficulty caused by the readinesss with which blood clots when it has left the body still remained. The physiology of the clotting of blood is even now, after a great amount of research has been done, an obscure and complicated subject. There is, however, definite knowledge of two of the conditions that are necessary in order that clotting may take place—firstly, contact of the blood with a rough surface which causes certain elements of the blood to disintegrate, and so initiates a chemical process resulting in the formation of a clot; and, secondly, the presence of the element calcium in an active form, since without this the chemical process cannot be completed. The first of these facts was met by the discovery that, if the blood be allowed to come into contact only with a smooth surface of paraffin wax, clotting was prevented or delayed. If, therefore, the blood be allowed to run into a vessel coated on its inner surface with a thin layer of wax, and then be immediately run into the recipient's veins, a measured quantity of blood can be transferred with comparative ease. This method is still used at the present time, but it presents some technical difficulties, and even in practised hands is not absolutely certain of success. The last and greatest advance was made in 1913, when it was discovered in an American laboratory that sodium citrate, a salt of the acid present in lemons and other fruits, will combine with the calcium of the blood in such a way as to render it inert. Sodium citrate, if injected into the circulation in some quantity, has a very poisonous effect; but the amount of it that is necessary to combine with the blood calcium is so small that the mixture of blood and citrate solution is as beneficial to the recipient as if pure blood were given. Clotting is by this means entirely prevented, and the whole process of transfusion is rendered both simple and certain of success.

There still existed, however, a certain danger in blood transfusion, for it sometimes occurred that the recipient, so far from benefiting by the transfusion, sudddenly and unaccountably died; it was evident that some unknown quality in the blood remained yet to be discovered. These fatalities found their explanation, about the same time that the citrate method was introduced, in the discovery by another American observer that certain individual peculiarities existed in the bloods of different people. Half the volume of the blood is made up of large numbers of "corpuscles," each a minute disc, slightly concave on both sides and only seven-thousandths of a millimetre in diameter. They contain in their substance the red pigment, hæmoglobin, to which the colour of the blood is due, and by virtue of this substance they have the power of combining with the oxygen of the air, which they pick up in the lungs and convey through the circulatory system to the various parts of the body. Their function is thus indispensable for the maintenance of the life of the animal which they serve. It was now discovered that these corpuscles, which are of very delicate structure, are in some people destroyed by substances in the fluid part of the blood of others. Although this destruction would usually result only in the loss of the corpuscles of the transfused blood without any harm being done, yet occasionally so potent a poison was produced by the change that the consequences to the recipient of the blood were fatal. It was also found possible to classify people into four groups which exist in a given race of people in almost constant proportions. Of these, one group, the smallest (1 per cent.), cannot give blood to anyone except to people of their own group, though they can be given the blood of anyone. A second group, fortunately the largest (44 per cent.), are able to give their blood to anyone without ill effects, though they can only be given the blood of their own group. The two remaining groups, of intermediate frequency (15 per cent. and 40 per cent.), are mutually antagonistic, though their blood can be given to members of the first group mentioned and of their own group. A test for these groups can be easily made and is completed in a few minutes, so that it is now the practice to use as blood-donors people of the second group or of the same group as the recipient. The danger of death from incompatibility of bloods has thus been eliminated. It is believed that this grouping is not dependent on any fortuitous conditions, such as diseases that the individual may have suffered from, but to be due to differences of a chemical nature, which are inherited in a definite, though as yet undetermined, manner. The blood of a baby is found to have its characteristic group reaction as soon as it is born, and it does not necessarily belong to the same group as its mother.

It is difficult to find out accurately the total amount of blood circulating in the body, but physiologists have estimated it to be between seven and ten pints. It is still more difficult, for obvious reasons, to find out how much blood a man may lose and yet remain alive; but the body can accommodate itself by various mechanisms to differences in amount within fairly wide limits, and it is this power of accommodation that makes it possible to take from the donor as much as a pint and a half of blood not only without danger, but often without any effect at all, though some donors experience a transient faintness. Probably nearly half the total amount of blood can be lost without necessarily causing immediate death; but there can be no doubt that the loss of as much as three pints of blood will put a severe strain on the mechanism of accommodation, and to some individuals would be extremely dangerous. If a man has been severely wounded on a battle-field, his collapsed condition may have been brought about by several factors besides loss of blood. The wound may have given a very severe shock to the whole nervous system, the man may be cold and in need of food and drink, and he may in addition have lost blood in any amount up to three or four pints. As a result his heart may be exhausting itself in an attempt to force the remaining blood round a circulatory system which has become too big for it, and his lungs are failing to do their work of oxygenating the blood owing to the inadequacy of the supply that reaches them. The body will replace a certain amount of fluid at the expense of the organs, but this amount is limited.

Until the methods of blood transfusion became widely known, doctors sought to replace the fluid that had been lost by injecting a solution of common salt in water into the circulation, and sometimes this served to tide the patient over a critical period. But often the effect was transient, the water that was injected being rapidly removed from the circulation and excreted. The immediate effect of blood transfusion upon a patient who is dying from loss of blood is one of the most gratifying sights that a surgeon can ever hope to see. The patient may have been literally within a few minutes of his death, but very soon after the beginning of the transfusion he begins to show signs of returning life. His breathing, from being a series of deep sighs, becomes normal, his pulse, previously very rapid and almost, if not quite, imperceptible, becomes slower and stronger, and his grey, drawn face regains its natural colour. The transfused blood, though probably not equal in amount to that which had been lost, has nevertheless served to turn the scale in favour of life, and the process has ensured that the patient shall, at any rate, not die from lack of blood. A blood transfusion carried out during the war was sometimes done under difficulties, and was apt to be a real race with death with a very brief margin of time; but however intense the effort, the result was nearly always an adequate reward. There was never any difficulty in obtaining volunteers for the office of blood donor. A number of men in hospital were usually tested for their blood groups before a battle, and the suitable ones chosen out. Most men took a genuine pleasure in saving the life of a comrade, and sometimes the rescue was effected under their very eyes. The donor was usually not ill-pleased to find afterwards that he was to get in addition three weeks' leave in England.

Towards the end of the war it was found that citrated blood could be kept unchanged for twenty-four hours or more, and in some hospitals the blood was drawn off from six or more donors when a battle was expected, and held in readiness; but even with this improvement it was still impossible during a long battle to carry out all the transfusions that were necessary. Physiologists in England therefore did much research in an attempt to discover a fluid which could be used as a substitute for blood and prepared beforehand in large quantities. It was necessary to find a non-poisonous solution which had approximately the same "viscosity," that is to say, the same physical properties, as blood, and would consequently not be removed so rapidly from the circulation as was the salt solution previously used. It was thought by some authorities that the corpuscles of the transfused blood were not important from the point of view of their special function as oxygen carriers, but that the maintenance of an adequate blood volume was the chief thing to be aimed at. Doubt has even been expressed whether the corpuscles of the transfused blood really carry out their proper functions in the recipient; but it has recently been shown that the visiting corpuscles can remain in the circulation for more than thirty days, and it is therefore almost certain that they can be as useful to the recipient as if his own corpuscles had been put back into his veins. Normally an adult person has approximately fifteen thousand million millions of corpuscles circulating in his body, and it is not difficult to believe that this number might be considerably reduced without ill effect. It was accordingly announced in 1918 that a satisfactory substitute for blood had been found in a specially prepared solution of gum-acacia, and it was used at once with high hopes of success; but it was found in France not altogether to justify the claims that had been made for it, and blood continued to be used whenever conditions permitted of it.

It is improbable that blood transfusion will ever be used on a large scale in civil practice, but it has already been found of great value for resuscitating patients who have undergone certain severe surgical operations; it has also been used with good effect in various diseases of the blood, such as pernicious anæmia, and has saved the lives of the unfortunate people known as "bleeders," whose blood, being deficient in the power of coagulation, continues to flow almost indefinitely after even a trivial injury. The injection of another blood gives the blood of the recipient, at any rate temporarily, an increased coagulability, so that the bleeder's wound is stanched. This effect is not spoilt by the admixture of citrate, although this is used as an anti-coagulant outside the body—a physiological paradox which has yet to be explained. Transfusion can also be used for cases of severe loss of blood due to accidental wounds. It is to be hoped that in hospitals it will always be possible to give a blood transfusion at very short notice; but the provision of blood donors is not so simple a matter in civil life as it was in the army. Already in America professional blood donors are to be found, who for a moderate fee are willing to sell a pint or more of blood several times a year; but Nature would not tolerate the letting of blood at intervals frequent enough to provide an adequate income, were this to be the donor's only means of livelihood. It is more probable that a suitable volunteer will have to be found for each case as the necessity arises.

WE hope to deal in the next issue with the following interesting books published by the Wireless Press:—*The Wireless Transmission of Photographs*, by Marcus J. Martin; and *Wireless Telegraphy and Telephony*, by H. M. Dowsett.

The Concert of Europe in the Nineteenth Century

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I

I TAKE it that one of the primary aims of DISCOVERY is to make new knowledge concerning the past, and new revelations concerning the present, available for the guidance of the future. Now, there can be no doubt that the hope of the future largely centres round the successful organisation and working of the League of Nations. It cannot, therefore, be without profit to ask what light history throws upon the difficulties and dangers which beset the path of those who attempt to constitute some form of International Government. The pages of history, particularly those that treat of the period subsequent to the break-up of Mediæval Christendom in the sixteenth century, contain many illuminating stories of efforts to co-ordinate mankind and establish perpetual peace among diverse sections of the human race. It is not the paper schemes of idealists like St. Pierre or Kant that are of supreme interest and importance. It is rather the practical attempts of statesmen and jurists to institute International Councils, to formulate an authoritative *jus gentium*, and to develop the machinery requisite for mediation and arbitration in disputes between peoples. To deal with these attempts at all completely would of course be a task far beyond the limits of a magazine article. But since the most significant of them are the latest, it may be profitable to give some special attention to these, and to ask what was the extent of the success and what were the causes of the failure of the Concert of Europe in the nineteenth century.

II

The Concert of Europe in the nineteenth century came into existence during the Napoleonic Wars. It was built up on the grand alliances which William Pitt and his successors organised for the deliverance of the Continent from the Corsican yoke. Its definite formulation may be assigned to the Treaty of Chaumont (March 10, 1814), the sixteenth article of which runs: "The present Treaty of Alliance having as its object the maintenance of the Balance of Power to secure the repose and independence of the Powers and to prevent the invasions which for so many years have devastated the world, the High Contracting Parties have agreed among themselves to extend its duration for twenty years from the date of signature, and they reserve the right of agreeing, if circumstances demand it, three years before its expiration, on its further prolongation." This compact marks a serious effort to establish a League of Nations, and to substitute for the tyranny of Napoleon an Amphictyonic Council of the Great Powers. The period which saw the most perfect manifestation of the operation of this embryonic Concert of Europe was that period of eight years, 1814 to 1822, which was marked by the overthrow of Napoleon and the resettlement of Europe on the old dynastic lines. The tremendous perils through which the nations had passed, the awful sufferings which they had endured, the strenuous and combined efforts which they had been compelled to exert in order to regain their freedom, had given them a sense of community such as they had never had before. Their leading statesmen had come to know one another intimately; they had learned the magnitude of their common interests; they had become accustomed to act together. This was particularly the case with the monarchs and ministers of the four Great Powers who had concluded the Treaty of Chaumont—viz., Alexander I and Nesselrode of Russia, Francis II and Metternich of Austria, Frederick William III and Hardenberg of Prussia, Wellington and Castlereagh of Britain. Round this inner circle there gathered in close though less influential co-ordination the representatives of Spain, Portugal, Savoy, and Sweden. Outside, but seeking some pretext for admission, hovered Louis XVIII and Talleyrand, the diplomatic chiefs of chastened and subjugated France.

The first achievement of the Concert of Europe as constituted in 1814 was the negotiation and conclusion of the Treaty of Vienna. This is not the place in which to discuss the merits and defects of this famous reconstruction of Europe which determined the course of Continental politics for three-quarters of a century. Suffice it to say here that in the circumstances no settlement could possibly have been satisfactory and final, and therefore that the gravest defect of the Treaty was that it contained no provision for the reconsideration or revision of any of its terms. They were all regarded as sacrosanct and immutable. The conclusion of the Treaty in 1815, however, did not lead, as on all similar occasions previously, to the dispersal of the negotiators and the cessation of their Conferences. For one thing, the period of the discussions at Vienna had witnessed the escape of Napoleon from Elba, his return to France, and his inauguration of the Hundred Days' campaign. When the Final Act of Vienna was concluded (June 9, 1815), the Battle of Waterloo had yet to be fought. It was necessary, then, for monarchs and ministers to keep together in order to complete the new campaign, and in order to decide on the new terms of punishment to be imposed on turbulent and unrepentant France. For another thing, there was a general dread of "The

Revolution" in the minds of all potentates and politicians; a general fear lest the peril from France should break out again; a general consciousness that the settlement of 1815 would need a good deal of safeguarding. Hence, after the overthrow of Napoleon, the diplomatic crowd migrated from Vienna to Paris, and when there not only imposed upon France a pacification proportionate in severity to the offence which she had committed in supporting Napoleon in his mad adventure of 1815, but also took steps to perpetuate the Grand Alliance, which had thus completed its primary task. Two very different schemes were propounded in Paris for the constitution of the permanent European Concert. The first emanated from Alexander of Russia, who had arrived in Paris in a state of high religious exaltation owing to the influence of the Baroness von Krüdener and her evangelical company, into whose hands he had fallen in June 1815. On September 26 of that year he announced his plan for a Holy Alliance which should include all the Christian rulers of Europe, and according to which all should pledge themselves "to take for their sole guide the precepts of the Christian religion, to strengthen themselves every day more and more in the principles and exercise of the duties which the Divine Saviour has taught mankind." To this Holy Alliance all the Christian potentates of Europe gave their adherence, except the Pope and the Regent of England. No one, however, apart from Alexander of Russia, and possibly Frederick William of Prussia, took it seriously. It was from the first a mere "scrap of paper."[1] It remained entirely inoperative, and when Alexander died, ten years later, it faded out of diplomatic memory altogether. Lord Castlereagh had, when the terms were originally laid before him, described it as "a piece of sublime mysticism and nonsense." He was, all the same, alarmed at it, knowing to what numerous and varied interpretations the Christian religion lent itself, and not knowing what ambitious schemes of Western hegemony floated through the unbalanced mind of the formidable Tsar of all the Russias. Hence he not only prevented the Regent of England from doing more than express a vague and general approval of the Tsar's exalted sentiments, he also advanced another and entirely precise and conventional type of union, according to which the four Great Powers which had entered into the Treaty of Chaumont should continue to maintain their Quadruple Alliance for the limited and definite purpose of securing and ensuring the observance of the Treaties just concluded at Vienna and Paris. It was in this Quadruple Alliance of the four Governments (November 20, 1815) rather than in the shadowy Holy Alliance of the miscellaneous monarchs that the Concert of Europe embodied itself. As a support to its deliberations and resolutions, a combined army of British, Russian, Prussian, and Austrian troops, under the command of the Duke of Wellington, occupied the north-east frontier of France. As an instrument for the formation of its opinions and the expression of its will, the Ambassadors of the four Powers met daily at 11 a.m. at the British Embassy in Paris. Never before had the ideal of an international authority for Europe been so nearly realised. This condition of things continued for three years (1815–18). Then another Congress was held at Aix-la-Chapelle, which, *inter alia*, arranged for the disbanding of the international army, the evacuation of the occupied French territories, and the cessation of the quadruple control of French affairs. The members of the Concert dispersed, and Paris ceased to be the scene of their diplomatic operations.

III

The harmony which, up to 1818, had in the main prevailed among the members of the Concert was after that date speedily broken. Britain was the first Power to strike a discordant note. At the Conference of Troppau (1820) she objected to the principle laid down by Metternich that in certain specified circumstances interference on the part of the Concert in the internal affairs of the Sovereign States of Europe would be justifiable; at the Conference of Laibach (1821) she protested against the intervention of the Concert in the domestic politics of Naples, where a revolution had overthrown the intolerable tyranny of the Bourbon Ferdinand; at the Conference of Verona (1822) she raised her voice against the proposed suppression of the constitutional government just set up in Spain, and against the proposed reduction of the Spanish American Colonies beneath the European yoke which they had repudiated. As in all three cases British objections and protests were ignored or overruled, Britain in 1823 withdrew from the Concert, and made her own settlements and arrangements with both the reconstituted European States and the revolted American Colonies. In respect of the latter she further came to an agreement with the United States of America in accordance with which the Monroe Doctrine was enunciated: both Powers resolved to prevent, by all necessary means, the interference of reactionary Europe in the development of progressive America. George Canning and John Quincy Adams combined to "call a New World into existence to redress the balance of the Old."

Whilst this schism between comparatively-liberal Britain and extremely-reactionary Austria, Prussia, and Russia was developing, another rift in the harmony of the Concert began to display itself. In 1821 the revolt of the Greeks against the Turks took place. Austria, under the leadership of Metternich, regarded this revolt as merely another instance of the rebellion of revolutionary subjects against the proper authority of their legitimate sovereign. She therefore encouraged the Sultan to crush the insurrection with all possible speed and all necessary severity. Russia, on the other hand, saw in the revolt the rising of an Orthodox Christian people against an infidel oppressor, and the passion of Russian sympathy, which in 1827 burst all the restraints of diplomacy, went out towards the struggling and suffering Greeks.

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[1] A German historian actually employs this expression, rendered so notorious by Bethmann-Hollweg in 1914. It is described by A. Stern, *Geschichte Europas*, vol. i, p. 41, as "ein wirkungsloses Blatt Papier."

Before the complete independence of Greece had been secured by Russian intervention, still a third line of cleavage had manifested itself in the European Concert. In 1830 Belgium threw off the yoke of Holland which had been imposed upon her in 1815, thus violating one of the main stipulations of the sacrosanct Treaty of Vienna. Russia, Austria, and Prussia united in protesting against Belgian action, and in maintaining the authority of the settlement of 1815. Britain and with her France (under the new Orleanist monarchy), on the other hand, championed the Belgian claim to self-determination. Thus by 1830 the Great European Powers were torn by dissensions. Along the three different and conflicting lines of democracy, religion, and nationality, the Concert was divided into discordant groups. Only the fact that the three group-sections were not the same, and not even parallel, prevented the schisms from developing into open rupture. Long before 1830, in fact, the defects of the Concert of Europe, as established in 1814–15, had become glaringly evident. They were, first, that the Concert was merely a league of Governments: it was alien from the peoples of the European States; it was antagonistic to the popular principles of democracy and nationality. Secondly, that it lacked a communal consciousness and a general will: its members were particularist and selfish, each bent primarily on his own prosperity and aggrandisement. Thirdly, that it was committed to the maintenance of a thoroughly unsatisfactory settlement—viz., the treaty settlement of 1815, which embodied the compromises of diplomatists and the concessions of dynasts rather than the desires of the public opinion of the Continent. Fourthly, that it possessed no organs, and had provided no instruments, for the modification of the treaties of 1815, or for the settlement of new problems which might emerge from the changing circumstances of the new age then just begining. Finally, that the sphere of its operations was inadequately defined, so that, while Castlereagh, and after him Canning, insisted on restricting it to international relations, Metternich and the reactionaries were able to extend its activities to include interference in the domestic politics of the European States. With these grave defects in structure and mode of working, it is no matter of marvel that the Concert collapsed between 1822 and 1830. The wonder is that it managed to maintain any sort of symphony so long.

(To be concluded next month)

The Measurement of Geological Time

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THE measurement of geological time depends on a comparison between the rate at which some process—geological, thermodynamic, radio-active, or astronomical—is going on at the present day, and the total effect of that process throughout the period of its activity. This is simply analogous to the fact that, if a body is moving with a known velocity, then the distance it travels gives a measure of the time taken. Average estimates of the rates of certain geological processes can be arrived at approximately; such, for example, as the rate of removal of detritus or soluble substances from the land surfaces, and the rate of deposition of sediments on the sea floor, or of the addition of salt to ocean waters. Knowing the total quantity of sediments that has been deposited since the hour-glass of denudation and deposition began its long career; or knowing the total quantity of salt that has accumulated in the seas since water first gathered in the ocean basins, it can be calculated to a first crude approximation how long these processes have been in operation. Thus, estimating the annual deposition of sediments at 9,000 million tons, and the total mass of sediments at 3,000,000 million million tons, the age of the oldest sediments works out by simple division at 330 million years. Similarly, estimating the total maximum thickness of all the sedimentary rocks at 335,000 feet, and the maximum average rate of present-day deposition at one foot in 900 years, the age is found by multiplication to be about 300 million years. However, these figures, although closely agreeing, must not be supposed to have any serious value, for they are clearly based on the assumption that the rate of sedimentation observed during a few decades represents the average rate for all geological time. To show that this assumption is not justified would require a long and technical discussion. It may, however, be confidently stated that present-day rates are abnormally high; that denudation and sedimentation move in rhythmic cycles, sometimes rapidly, as now, but at other times much more slowly; that the rate of sedimentation is controlled not only by the supply of material, but also by the rate of relative subsidence of the sea floor; and, finally, that there are innumerable time-intervals unrepresented by layers of sediment in almost every part of the geological record. We may therefore be prepared for figures far in excess of even those crudely arrived at in the above estimates.

The early geologists were apt to be somewhat casual in their estimates of geological time, particularly as the latter were necessarily based more on sentiment than on quantitative data. More than half a century ago Sir William Thomson, afterwards Lord Kelvin, invaded the mists of speculation in which the subject was then enveloped, hoping to disperse them with the wand of thermodynamics. It is well known that, as the earth's crust is penetrated by bore-holes and mine-shafts, a steady increase of temperature is encountered. On the assumption that the temperature gradient of the earth was the result of simple cooling from a molten state, and knowing the average thermal properties of rocks, Kelvin was able to calculate within limits the time that must have elapsed since the consolidation of the crust took place. The first limits were 20 and 400 million years, with 100 million years as the most probable figure. Later, however, he reduced his limits to 20 and 40 million years, with a tendency to favour the shorter period. The long controversy which raged around these results is one of the familiar details of Victorian scientific history. Although a few geologists, impressed by Kelvin's authority and apparently unimpeachable reasoning, were willing to adapt themselves to the very severe limitations imposed, others, like Geikie and Goodchild, demanded far less restricted periods for the varied changes of life and scene revealed by the long succession of records preserved in the rocks. There was a hope, slight indeed at first, though afterwards fulfilled beyond all expectation, that some underlying flaw would be found in the thermodynamic arguments. It might have been pointed out that the latter ignored the great convection currents represented by the rise of granites and other products of igneous activity; but even had the calculations been modified to include such transfer of heat, the resulting estimates would have been little higher, if at all, than Kelvin's final maximum. In justice to Kelvin, however, it is only fair to state that he clearly realised that his estimates would fall to the ground if it could be shown that the earth contained within herself supplies of potential energy which, liberated as heat, would counterbalance the external loss by radiation. With the discovery of radio-activity the real flaw was at last detected, and it was found, contrary to Kelvin's assumption, that the earth is not a simply cooling body.

The examination of pitchblende by Mme. Curie led to the discovery of radium, and later it was found that radium is constantly being formed as one of a long series of elements which arise from the spontaneous atomic decay of uranium. During this disintegration radiations of three types are emitted by the unstable elements: α-rays, consisting of positively charged atoms of helium; β-rays, identified with streams of (negatively charged) electrons; and γ-rays, of the same nature as X- or Röntgen-rays. After three atoms of helium have been discharged from the parent element, uranium, and its immediate descendants, radium is reached. Radium in turn decays, and as the rate of disintegration of each member of the family is proportional to the quantity of it which is present, an equilibrium is ultimately reached in which a constant ratio is established between the amount of uranium and that of each of the unstable daughter elements. The ratio of uranium to radium, for example, is 3,000,000 to 1. From the disintegration of radium, helium and a gas known as niton, or radium emanation, are evolved, and it is due to the easy detection and measurement of the emanation that small quantities of radium or uranium can be estimated. The emanation continues to break down, and ultimately a stable end-product which is chemically identical with lead is reached. When the whole family has fallen into equilibrium, the decay of one atom of uranium implies that of an atom of each of the unstable daughter elements, and the generation of eight atoms of helium and one of lead. The helium and lead, being stable, gradually accumulate in proportion as their ultimate parent, uranium, is destroyed. An atomic equation representing in two stages the total change is as follows:

$$\begin{array}{ccccc} \mathrm{U} & \rightarrow & \mathrm{Ra} + 3\mathrm{He} & \rightarrow & \mathrm{Pb} + 8\mathrm{He} \\ \underbrace{238}_{238} & & \underbrace{226 + 12}_{238} & & \underbrace{206 + 32}_{238} \end{array}$$

It will be noticed that the atomic weight given for "Pb" is 206, whereas that of ordinary lead is 207·2. That this difference of atomic weight is real has been established beyond question by actual determinations on lead separated from uranium-bearing minerals in which the stable products of decay have accumulated through long geological periods. To this aspect of the subject we shall return for a more detailed discussion. Thorium is another parent radioactive-element, and its disintegration leads to the generation of helium at six stages with lead again as the probable end-product. The "lead" of the thorium family has apparently an atomic weight of about 208, but unfortunately its genesis and accumulation are not yet as well understood as in the case of uranium-lead.

With this brief introduction to the nature and results of radio-active change, we may proceed to consider their bearing on the measurement of geological time. The helium atoms discharged as α-rays are explosively emitted with very high velocities, in some atoms even approaching that of light. The atomic energy thus liberated is transferred to the molecules encountered by the helium projectile in its course, and appears as heat. In 1903 it was discovered that radium is constantly giving out heat; and evaluating all the contributions from its associated elements, we now know that the total generation of heat from the family represented by 1 gram of uranium amounts in a year to 0·7 calories. Similarly, from 1 gram of thorium in equilibrium the heat output amounts to 0·2 calories per annum. These amounts may appear to be trivial, but they suffice to provide the earth with such an embarrassingly large quantity of heat that it becomes necessary seriously to consider why the earth is not growing hotter. A simple calculation shows that a distribution of uranium throughout the earth amounting to only 5 parts in 100 million parts of rock would suffice to balance the loss of heat by radiation. The Hon. R. J. Strutt, now Lord Rayleigh, devised an accurate method for determining the uranium content of rocks, and his results and those of others show that the rocks contain 120 times more than is required. When to this the heat effect of thorium is added, it is found that, if the radio-active elements were uniformly distributed, then the amount of heat generated within the earth would be 300 times greater than the amount required to maintain a state of thermal balance. Since it is impossible to believe that the earth has been growing hotter at such a rate, it follows either that radio-active substances cease to give out energy in the deep interior of the earth, or else that they are restricted in their occurrence to the crustal rocks. Both hypotheses have their adherents; but whereas there is no experimental support for the former, there is a concordant body of evidence favouring the view that the deeper zones of the earth are free or practically so from these surprisingly energetic elements. The nature of this evidence need not here be discussed. It is sufficient to realise that the necessity of either hypothesis indicates how completely the foundations of the cooling argument have been destroyed. While it still appears probable that the earth's surface was originally in a state of aqueo-igneous fusion, it is certain that the cooling-down process has been extremely slow. The following figures show how the "age" is increased according to the proportion of radio-active heat admitted.

Proportion of heat lost by radiation attributed to radiothermal energy.	Period of cooling required to reach the present temperature gradient.
0	20 million years
$\frac{1}{4}$ or 25 per cent. . .	40 " "
$\frac{1}{2}$ " 50 " " . .	120 " "
$\frac{2}{3}$ " 67 " " . .	580 " "
$\frac{3}{4}$ " 75 " " . .	1,600 " "
$\frac{4}{5}$ " 80 " " . .	7,200 " "

The discovery of radio-activity not only revealed with dramatic suddenness the unjustified restrictions which had been placed on geologists, but it led directly to the elaboration of the most elegant and refined method of measuring geological intervals of time that has yet been devised. Every fresh uranium-bearing mineral is now regarded as a natural chronometer, registering time by the atoms of helium and lead that are produced unceasingly within it year after year.

In 1910 Strutt directly measured the rate of formation of helium in the minerals uraninite and thorianite. He showed that 1 gram of uranium in equilibrium with all the members of its family generates 1 c.c. in 9 million years, and that for thorium the corresponding rate is 1 c.c. in 32 million years. In the case of the thorianite Strutt found that it originally contained 280 million times the amount of helium that could be generated in a single year, and therefore that the time required for its accumulation must also have been 280 million years. Before asserting that this figure is also the age of the mineral, three questions must be asked and answered:

(*a*) Was there any helium present in the mineral at the time of its crystallisation?

(*b*) Has the rate of production of helium been uniform from year to year?

(*c*) Has any helium escaped from the mineral during the period that has elapsed since its crystallisation.

The first question is answered by the fact that ordinary rocks and minerals contain only the slightest traces of helium, and that, if a radio-active mineral did contain a little of the gas as an original impurity, its amount would soon become quite negligible compared with the large amounts actually generated.

The second query presents little difficulty. No physical or chemical conditions that can be imposed on radio-active substances affect their behaviour in the slightest degree, and therefore the only variation in rate that can reasonably be considered is that due to the slow decay of the parent element, uranium. Since out of 7,000 million atoms of uranium only one disintegrates per year, it is clear that the correction to be applied is very slight.

Finally we must consider the possibility of leakage. It has been experimentally proved that as soon as a radio-active mineral is exposed to the air it begins to lose helium. On grinding for analysis more is lost, and consequently it must lose a considerable amount before it is even collected in the field, especially when, as in the case of thorianite, it occurs in gravels which have been subject to the action of the weather for hundreds or perhaps thousands of years.

It is clear, therefore, that the helium now found in a mineral can be only a fraction, and sometimes only a small fraction, of the total amount which has been generated within it, and which alone could give a true estimate of its life-time. Returning to the thorianite investigated by Strutt, it will now be seen that it would be quite wrong to suppose that its age is 280 million years. The actual age must be considerably greater than that, and it should be carefully noticed that helium determinations never can provide data for more than a *minimum* estimate. All that the helium-ratio can tell us is that the age of the mineral to which it refers is greater than a certain minimum value. In the table below some of the minimum values which were obtained by Strutt are listed in order of geological age, and it will be noticed that in general they are less than half the corresponding values obtained from lead-ratios. To these, and the more reliable figures deduced from them, we may now turn our attention.

The original suggestion that lead is the stable end-product of the uranium family was made by Boltwood in 1905, and more recent discoveries have uniformly converged to demonstrate the correctness of his view. It is found that in fresh, primary uranium-bearing minerals of the same geological age, the amount of lead is closely proportional to that of uranium. Moreover, when series of minerals of different geological ages are compared, it is found that the ratio of lead to uranium increases with the geological age. Before the lead-ratio can be accepted as a reliable age-index, the questions discussed in the case of helium must, however, be answered satisfactorily.

If lead should have been originally present in uranium-mineral at the time of its formation, the age deduced will clearly be too high. Although lead is a negligible constituent in all the ordinary primary minerals of igneous rocks, it is possible that it may be present in certain radio-active minerals which are themselves associated with galena, the common ore of lead. Fortunately, however, it is possible to detect the presence of primary lead by means of an atomic weight estimation. If lead is wholly primary, its atomic weight is 207·1; if generated from uranium, the atomic weight is 206. Values between these figures indicate a mixture, and provide a means of determining the proportion of the total lead which is of radio-active origin.

The rate of production of lead in uranium minerals is not likely to have varied during their long history except for the gradual decrease due to the decay of the parent-element. As pointed out in connection with helium, no known agency has proved itself capable of affecting the rates of radio-active changes to the slightest detectable degree. From the rate of production of helium, a rate that is now accurately known from several independent methods of investigation, it is easy to calculate that 1 gram of uranium produces lead at the rate of 1 gram in 7,500 million years. Knowing the percentage U of uranium in a mineral, and that of lead, Pb, the age of a mineral to a first approximation is evidently $\frac{\mathrm{Pb}}{\mathrm{U}} \cdot 7{,}500$ million years. However, as the existing percentage of uranium is necessarily less than that originally present, a more accurate formula is $\frac{\mathrm{Pb}}{\mathrm{U} + 0{\cdot}575\mathrm{Pb}} \cdot 7{,}500$ million years, where $(\mathrm{U} + 0{\cdot}575\mathrm{Pb})$ is the average value of the uranium present during the life-history of the mineral. The figure taken from Pb may also have to be corrected by reference to an atomic weight estimation, but in practice none of these modifications make any serious difference to the order of the period of time finally arrived at.

So far the influence of thorium as a generator of lead has not been discussed. Although the evidence seems conclusive that lead is also the end-product of the thorium family, yet in thorium minerals of apparently identical geological age the ratio Pb/Th is often extremely variable. This inconsistency appears to be related to the fact that thorium minerals are usually very much altered, and in them neither the Pb/Th nor Pb/U ratios give reliable results. It is of course obvious that, if a mineral is altered, it has suffered chemical changes whereby the normal lead ratio is upset, for either introduction or elimination of lead may have taken place. The well-known radio-active minerals from Llano Co., Texas, are a warning example of the effect of alteration. Some of them are fresh and give a ratio of 0·17 for Pb/U, but others are secondary alteration products, and give ratios ranging up to 1·15.

In order, therefore, that age determinations should be reliable, it is essential that the minerals tested should be chemically stable, microscopically fresh, and of definitely known geological age. Further, since thorium minerals are frequently altered and give widely varying results, the minerals chosen should be those in which the parent radio-active element is predominantly uranium. If these conditions are fulfilled, the reliability of the experimental results can then be judged by two further criteria. The lead-ratios of a series of minerals of the same age should be concordant among themselves, and the atomic weight of lead separated from the minerals should be of the correct order.

Satisfactory minerals are available for dating three of the geological periods fairly closely. Uraninite of Eocene (Lower Tertiary) age gives a ratio indicating that 70 million years have elapsed since it crystallised. For the Permo-Carboniferous igneous rocks of three different localities, ages of 300 to 340 million years are obtained. For the Middle Pre-Cambrian, a group of periods which includes at least two great epochs of igneous activity, ages varying from 900 to 1,120 million years have been deduced. The oldest mineral hitherto analysed appears to be a zircon from the Lower Pre-Cambrian of Canada. This gives an age of 1580 million years, but as it is based on a single analysis, it can only be considered to give an approximate estimate of the time that has elapsed: However, the figure is probably substantially correct, as it is supported by helium-ratios which, as usual, give less than half the period represented by the corresponding lead-ratio.

The data so far collected are summarised below in tabular form, and it will be noticed that in some cases the lead-ratio can be used, as in Mozambique, for determining the geological position of rocks which yield their age to no other method of investigation. There is, for example, no doubt that the zircons from Mozambique point to Middle and Lower Pre-Cambrian ages for the rocks from which they were respectively obtained. The correlation of the Pre-Cambrian formations in different parts of the world has long been one of the most difficult problems with which the geologist has been faced. The method of lead-ratios, however, has already done good service in leading the way towards a world-wide solution.

In conclusion it may be pointed out that the age of the earth is likely to be greater than, say, 1,600 million years, for the oldest known igneous rocks are themselves intrusive into sedimentary formations which in turn must have been derived from still older igneous rocks. The latter may possibly have been the original crust of the earth, but of this no certain trace has ever been detected. Now, as in Hutton's day, geologists can still find "no vestige of a beginning." Astronomical considerations, however, have shown in recent years that the new demands on geological time are not too high. The movement of the solar system across the void of space from its supposed birthplace in the Milky Way is a journey for which something approaching 3,000 million years is a dynamical necessity. Supporting this figure is an estimate by Dr. Harold Jeffreys of the age of the solar system. From a consideration of the present orbital elements of Mercury and their evolution, he finds that the requisite order of

GEOLOGICAL TIME SCALE, BASED ON THE LEAD-URANIUM RATIOS OF RADIO-ACTIVE MINERALS

(For comparison the ages calculated from helium-uranium ratios are given on the left. The much lower figures are, as explained in the text, due to the partial escape of helium from minerals before they can be analysed.)

Millions of Years.	Minerals of which Helium-ratios are known.	Geological Periods.	Minerals of which Lead-ratios are known.	Millions of Years.
1	Zircon, Mayen, Eifel . . .	Pleistocene		
2·5	Zircon, Campbell Is., N. Zealand .	Pliocene		
6·3	Zircon, Expailly, Auvergne . .	Miocene	Brannerite, Idaho	30
		Oligocene		
31	Hæmatite, Antrim . . .	Eocene	Uraninite, Gilpin Co., Colorado . .	70
		Cretaceous		
		Jurassic		
		Triassic		
		Permian	Uraninite, Glastonbury, Connecticut .	300
146	Hæmatite, Forest of Dean .	Carboniferous	Uraninite and Zircon, N. and S. Carolina .	330
147	Zircon, N. Carolina . .		Pitchblende, St. Ives, Cornwall . .	340
145	Hæmatite, Caen	Devonian	Various, Brevig, S. Norway . . .	360
			(?) Uraninite, Branchville, Connecticut .	390
209	Zircon, Miask, Urals (?)[1] . .	Silurian		
		Ordovician		
		Cambrian		
307	Thorianite, Ceylon (?) . . .	Upper Pre-Cambrian	(?) Uraninite, Morogoro, E. Africa . .	660
				900
			Uraninite, Singar, India . . .	940
			Uraninite, etc., Moss District, S. Norway .	1,000
			Gadolinite, etc., Ytterby, Sweden . .	1,030
405	Sphene, Arendal, S. Norway .	Middle Pre-Cambrian	(?) Zircon, Mozambique	1,120
410	Sphene, Twedestrand, S. Norway .		Uraninite, etc., Arendal, S. Norway .	1,120
			Uraninite, Villeneuve, Quebec . .	1,120
			Uraninite, Llano Co., Texas . . .	1,120
			Zircon, Ceylon	
623	Zircon, Renfrew Co., Canada .	Lower Pre-Cambrian	(?) Zircon, Mozambique	1,430
715	Sphene, Renfrew Co., Canada .		Zircon, Sebastopol, Canada . . .	1,580

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[1] The sign (?) indicates that the geological age of the rocks in which the mineral occurs has not been unequivocally determined. In any such case the numerical age deduced from lead-ratios cannot be considered as a contribution to a geological time scale, but according to the place it occupies in the latter it may conversely be used as evidence of the geological age of the mineral and rock in question.

time is roughly 3,000 million years. Thus the earth recedes into an inconceivable remoteness far beyond the bounds of geological investigation, and there we must forsake her, and invite the astronomer, whose laboratory is the universe, to carry the story back still further.

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The Architecture of the Next Twenty Years

By W. S. Purchon, M.A., A.R.I.B.A.

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In order to be in a position to appreciate the changes which are coming over the art of the architect in this country, it is necessary to glance at the development of architecture since the Gothic Period. In a brief article it is hardly possible to do more than mention a few of the major movements—the coming of the Italians during the reign of Henry VIII; the influence of the less refined work of Germany and the Low Countries in the days of Elizabeth and James I; the introduction of mature Italian design by Inigo Jones, and its vigorous development by our greatest architect, Sir Christopher Wren; the work of the amateurs of the eighteenth century; and the Greek Revival of the closing years of the eighteenth and the early part of the nineteenth centuries. During the development of the latter movement, the greatest monument of which is St. George's Hall, Liverpool, a return was made to the types of design which flourished in the Middle Ages, the rival schools indulging in the famous "Battle of the Styles." A further complication was a contemporaneous undercurrent of more or less pure Italian work.

During the third quarter of the nineteenth century George Devey, Norman Shaw, and others grasped the facts that we were not living in either Greece or Italy, and that the conditions of life had undergone serious changes since the time of Pericles, or even since the equally fascinating days of the Black Prince; and they attempted to base an architecture on the later traditional work of our own country and the special requirements of their own times. Largely to their efforts do we owe our acknowledged position as house designers.

The so-called "Queen Anne" style which resulted was subjected first to a coarsening process, and then to two further cross-currents—the "New Art" movement, which did some good by drawing increased attention to the importance of material; and a further attempt to get back to the fountain-head and to the use of Greek detail and forms as the alphabet of our architectural language. Possibly in sympathy with the *Entente Cordiale*, architectural forms which had received the sanction of Paris were also admitted by those who otherwise drank only from the Pierian spring. A better thing was, however, coming to us from the French capital—a greater ability to deal with the planning of buildings on a large scale.

And so the war found us: possessing considerable ability in the design of country houses, and some little trick of planning larger buildings on axial lines, and very interested indeed in the design of façades in the fashionable manner.

A note of warning had certainly been sounded by a few who saw that all was not well, and that salvation would not be found through the medium of ancient Greece with a dash of modern Paris, even if the façades were crowned with balustrades faintly reminiscent of the Union Jack. Whisperings of ferro-concrete were heard, ideas of Town Planning were drifting across the English Channel, and here and there a grandiose scheme for the embellishment of one or other of our cities was prepared, but it very rarely materialised. There was much talk of housing reform in the air, and a garden city and a few garden villages were actually built.

. . . . .

And now that the war has passed over us, leaving in its wake this somewhat peculiar peace, what is to become of architecture?

In the first place, the cost of building is now from two to three times as great as in pre-war days; secondly, the insistent demand is for houses, all the houses, and nothing but the houses (with a possible exception in favour of war-memorials); and, thirdly, the architects have been up against grim facts. Some of these facts are of a type which will hardly bear writing about, and in any case this is certainly not the place in which to write of them.

It seems clear, however, that those who are going to make the architecture of the next twenty or thirty years have passed far beyond the "pretty-pretty" stage. To them the art is a great and a serious one. They are neither the amateurs of the eighteenth century nor the archæologists of the first half of the nineteenth. Possibly they may base their work on the details of the buildings on the Athenian Acropolis, more probably on the sound and vigorous work of the architect of St. Paul's (work more in harmony with our climate and our usual building materials); but the important thing is that they will be practical artists, in touch with modern requirements and modern methods of construction.

Broadly speaking, the high cost of building work will lead naturally to a process of simplification; a consideration of the cost of upkeep will result in soundness of building, and the feeling of these days through which we are passing will surely find expression in an austere beauty.

The richness of the East and the wealth of ornament of the fourteenth century may not be possible, while the vagaries of the days of Watteau and Meissonier——to take an extreme example—would be out of place; but without these there can, and there will, be great and noble building.

Much of the coming building will be—as has been stated—of a domestic character, and for this our traditions and training fit us well. Any weakness there was in our pre-war small house design was a tendency to fussiness, a tendency which is largely overcome by the conditions previously stated.

Important is the fact that the very vastness of our housing problem has led us to see that it must be tackled in a comprehensive manner. It has been clearly seen that the task of building the new homes and gradually getting rid of unhealthy dwellings necessarily raises the whole question of the right development of towns and cities. Great slum areas must be cleared as soon as sufficient new houses are ready, and thought is being exercised as to the right use of the sites. Traffic problems of increasing difficulty are being experienced in our larger cities, and the only sound method of tackling these and other difficulties is by means of the Civic Survey and the comprehensive town plan. The town—in some cases the town with its surrounding district, or in others a group of towns—is seen to be the unit; and the dictates of economy compel adequate investigation of existing conditions followed by systematic development, instead of the haphazard growth of pre-war times.

Thus in the case of housing it is clear that our extremity is really our great opportunity. As yet the new dwellings are coming all too slowly; but from the technical point of view the great scheme of putting right the housing of the people has been conceived on big and sound lines. Individually the houses will be more efficient than in the past, they will be pleasantly simple externally, and interest will be given by their disposition in short blocks on roads which have been carefully designed to suit the contours of the sites. And while the earlier sets of new houses are being erected, the schemes for dealing with the towns they adjoin are being matured.

Not only must provision be made for ample recreation spaces and allotments, but suitable sites must be reserved for a variety of public buildings which will be required at a later date. Already there is a serious shortage of schools, and large numbers will be required if education is to develop on sound lines. In all probability the school buildings—and possibly the hospitals—of the near future will be on less permanent lines than those of the past. This would be a sound step from a practical point of view, and it need not be regretted on æsthetic grounds, as it may well lead to interesting experiments with colour.

Many new public buildings of permanent character will, however, be required as the centres of population change with the development of our towns, and these buildings will give ample opportunities for the ex-service students who are now filling our schools of architecture.

There are difficulties ahead, but difficulties are more often than not a help to the able architect—Wren obviously revelled in the task of surmounting them—and it is the belief of the writer that our young men will rise to the occasion.

BOOKS RECOMMENDED.

Lethaby, *Architecture.* (Williams & Norgate, 2*s.*)
Statham, *A Short Critical History of Architecture.* (Batsford, 12*s.*)
Anderson and Spiers, *The Architecture of Greece and Rome.* (Batsford.)
F. Bond, *Gothic Architecture in England.* (Batsford, 34*s.*)
Anderson, *Italian Renaissance Architecture.* (Batsford, 16*s.*)
Ward, *Architecture of the Renaissance in France.* (Batsford, 40*s.*)
Gotch, *Early Renaissance Architecture in England.* (Batsford, 18*s.*)
Blomfield, *A Short History of Renaissance Architecture.* (Bell, 7*s.* 6*d.*)
R. Unwin, *Town Planning in Practice.* (Fisher Unwin, 42*s.*)

Wireless Waves

By Lt.-Col. C. G. Crawley, M.I.E.E.

In wireless signalling, energy is transferred from the sending station to the receiving station without any transference of matter, in an exactly similar manner to that in which light, heat, or sound is transmitted from one place to another.

In each case the energy is transferred by wave motions in the intervening medium.

Now, light and heat are transmitted from the sun to the earth not only through the atmosphere, but also through millions of miles of empty or vacuous space, so that the medium for the propagation of light and heat, whatever it is, is not a solid, a liquid, nor a gas, but must be something which is present in a vacuum.

This medium is called the Ether, and the laws of the propagation of energy by light, radiant heat, and wireless telegraphy can be proved if this ether is assumed to be present everywhere and to have certain definite properties.

The existence of a medium with these properties is therefore a fair assumption to make, unless, or until, some observed phenomenon requires its modification.

In this connection, for instance, it is possible that the result of recent observations of the sun's eclipse may require some modifications to be made in certain assumptions regarding the transference of energy by ether waves.

The energy which produces sound is also transmitted by wave motions of a medium, which in this case, however, is gaseous (as air), or solid or liquid.

The difference in the media in the cases of sound and light can be readily demonstrated by connecting up an electric bell and its battery under the receiver of an air-pump so that the space surrounding the bell, enclosed in the glass receiver, can be exhausted as far as possible of air. It will be found that, as the air becomes more and more rarefied, the sound of the bell decreases, eventually ceasing altogether when the receiver is exhausted of air. The hammer, however, can still be seen striking the bell, which shows that light is traversing the exhausted space, whereas sound is not.

The method by which energy can be transferred by wave motions in a medium can be seen by dropping a stone into a pool of water. The energy imparted to the water by the stone is radiated in the form of a circle of waves, the circle increasing in size, and the heights of the waves becoming smaller, until they reach the edges of the pool, or die away altogether. Now, if some corks are floating in the pool, the energy imparted to the water by the stone, and propagated by the waves, will cause the corks to bob up and down, thus showing that the little particles of water, which are in this case the medium, merely oscillate up and down, and by doing so, convey energy in the form of waves, the corks nearer the original disturbance receiving more energy than those farther away.

The stone, by disturbing the water at one place, has thus transferred energy to other places by waves in the medium, the water, without any transference of matter taking place.

Similarly, if one end of a piece of rope is fixed, and the other end is rapidly moved up and down by hand, energy is transferred by wave motions in the rope from the hand to the place where the rope is attached without any matter being transferred from the one end of the rope to the other.

In both these cases the wave motion by which energy is transferred is produced by oscillation of the little particles which make up the medium—that is, the water or the rope, up and down at right angles to the line of propagation of the energy. A wave length is the distance separating the crests of adjacent waves, and it will be apparent, by observing the motions of the rope, that the more rapid the oscillation the shorter are the wave lengths, and vice versa.

It is in just such a manner that light and heat are transmitted from, say, the sun to the earth, except that the oscillations of the medium, in this case the ether, take place not only in one direction, but in all directions at right angles to the line of propagation.

If the oscillations of the ether are at certain rates, they affect the eye and produce the sensation of light; if at certain other rates, they are received not as light, but as heat.

If the ether is set in oscillation at very much slower rates than can be detected as light or heat, the ether waves produced are those which are used for communication by Wireless Telegraphy. These wireless waves are often called Hertzian Waves, after Hertz, a German physicist, who in 1878 published the results of his experiments on the production and properties of these waves, results which confirmed theoretical deductions published in this country by Clark Maxwell in 1864.

The transference of energy by all these ether waves, light, heat, and wireless, takes place at the same rate, viz. 186,000 miles a second; but the rates of oscillation of the ether on which depend the lengths of the waves differ very much in each case.

The highest known rates of oscillation in the ether produce Röngten or X rays, then come the actinic rays, which are used in photography, and then the visible light rays, at rates of oscillation from about 1,200 billions a second for violet light, down through indigo, blue, green, yellow, and orange, to about 600 billions a second for red. A combination of all these colour rays produces white light, i.e. sunlight. Below these rates of oscillation are the heat rays, and then the rates of oscillation, about 3 millions to 15,000 a second, which produce the Hertzian waves now used for wireless signalling.

These wireless waves are therefore very similar to heat or light waves, and travel at the same speed, the main difference being that the rates of oscillation of the ether which produce them, though so exceedingly rapid, are far too slow to produce the sensation of heat or light; in other words, these wireless waves can be neither felt nor seen. Neither, of course, can they be heard, as they have no connection whatever with audible sounds, which are produced, not by ether oscillations, but by air oscillations, acting on the drum of the ear.

The speed of travel of ether waves, 186,000 miles a second, is so great as to be, for all practical purposes, instantaneous so far as propagation over the earth is concerned; though when the stupendous distances dealt with in astronomy are considered, this speed is, of course, far from instantaneous. For example, it takes some eight minutes for light from the sun, and about four years for light from the nearest star, to reach the earth.

Signalling by an unscreened flashing lamp may be taken as an example of signalling by light waves, flashes of short and long duration representing the dots and dashes of the Morse Code. These flashes consist of trains of ether waves which radiate in all directions at a speed of 186,000 miles a second, the oscillations getting weaker and weaker as the distance from the lamp increases, until at last they have dissipated their energy and die away altogether. The eye can be used to receive these signals, and the message in the Morse Code can be read simultaneously from all directions by any number of people within range, provided that there are no screening effects caused by opaque bodies intervening between their eyes and the lamp.

Wireless signals are sent in a very similar manner by short and long trains, or series of trains, of ether waves which travel outwards from the sending station in all directions at this same speed of 186,000 miles a second. These trains of waves actuate, as dots and dashes, according to their duration, the wireless receiving instruments at any number of stations which are within range, and are adjusted to respond to the particular wave length used.

These long ether waves are able to pass readily through bodies which are opaque to light or heat waves, unless such bodies consist of, or contain, conductors of electricity, in which case the waves produce currents of electricity in the conductors, and so part with some of their energy.

Screening effects in the case of wireless waves are therefore very different from those which obtain in the case of light waves; for example, buildings, etc., opaque to light waves, may present no obstacle whatever to the passage of wireless waves; even mountains, and indeed the obstacle caused by the earth itself, do not affect these waves in the same way as they affect light waves.

For instance, there is no difficulty in signalling by wireless waves across the Atlantic, whereas it is impossible to signal over distances of more than a comparatively few miles by light waves, owing to the earth imposing, due to the curvature of its surface, an impenetrable obstacle to such waves. In the case of the Atlantic Ocean this obstacle would represent a mountain some hundreds of miles in height, and the waves do not actually pass through this obstacle, but may be considered as gliding over the surface. Like light waves they are subject to absorption, to reflection, and to other forms of bending, as refraction and diffraction, on account of which mountains or other high land close to a wireless station may produce serious screening in that direction, whereas the same obstacle at a distance may have very little or even no appreciable effect. Short waves are much more affected by this land screening than are long waves; but in any case it is advisable to avoid siting a wireless station close to higher ground in a direction towards which communication is required.

Absorption and bending effects in the atmosphere account for the fact that signals, especially when using short waves, can be transmitted to much greater distances by night than by day, and that these night ranges may vary considerably during the same night, and from one night to another.

For signalling by wireless, the sending station does not transmit a number of ether waves of various lengths at the same time, as is the case when signalling by light, but makes use of one wave length only for that particular transmission.

All wireless communication is not, however, carried out on the same wave length, as if it were the receiving stations would receive a jumble up of all the messages being sent on that wave length from stations within range, instead of the particular message which it was desired to receive. When the reception of a message is thus interfered with by other messages being sent at the same time, the message is said to be "jammed." This jamming of a message may also be caused by stray ether disturbances in the atmosphere itself. These disturbances are called "atmospherics" or "strays," and are specially strong when thunder-storms are in the vicinity, lightning itself causing very violent atmospheric disturbances. Atmospherics often cause great interference with wireless communications, and in tropical countries are sometimes so strong as to prevent any communication at all for hours at a time. They are strongest as a rule at night and in the afternoon. In more temperate latitudes, as in this country, atmospherics are usually at their worst during the night in summer-time, but are seldom so troublesome as those experienced in warmer climates.

The actual choice of the wave length will depend on various considerations—for example, high-power long-range stations cannot be arranged to transmit short waves, and low-power short-range stations, such as those in ships, cannot be arranged to transmit long waves.

All commercial ship and coast stations are fitted so as to be able to transmit on wave lengths of 600 and 300 metres, the intention being that communication, if jammed on the one, may possibly be established on the other.

The S.O.S., or distress signal, is always sent on the 600 metres wave, as this is the wave length for which the receiving apparatus in all ships is normally adjusted.

BOOKS RECOMMENDED

Waves and Ripples in Water, Air, and Aether. By J. A. Fleming, D.Sc., F.R.S. (S.P.C.K., 7s. 6d.)

Textbook on Wireless Telegraphy. Vol. I, General Theory and Practice. By Rupert Stanley, B.A., Temp. Major R.E. (Longmans, 15s. net.)

The Antiquity of Man in East Anglia

By E. N. Fallaize, B.A.

WITHIN the last few years investigation of the deposits of gravel and clay of Glacial and Pre-Glacial Age in the neighbourhood of Ipswich has furnished a considerable body of evidence which throws fresh light on the early history of man in Britain, although, owing to a variety of causes, it has not perhaps received the attention that it deserves. One of the most interesting of these discoveries was recently described at a meeting of the Royal Anthropological Institute, when Mr. J. Reid Moir, by whom the greater part of these investigations has been carried out, exhibited a number of flint implements obtained from the Chalky Boulder Clay in the neighbourhood of Ipswich. The implements were found, during a period extending over some twelve years, in pits excavated for the purpose of brick-making. They do not occur in any great quantity, but Mr. Reid Moir has secured a number sufficient to furnish a definite idea of the type, and with some probability of the stage of culture to which they belong. So far as the form and technique of these implements go they are to be assigned to the Mousterian type, so-called from the site of Le Moustier in France where implements of this type were first discovered.

It will perhaps be necessary at this point to explain that in the classification of the French archæologists, which is generally accepted, the Palæolithic Age is divided into six periods or phases of culture, each named after a characteristic site in France. The implements belonging to two of these periods or phases——the Chellean and the Acheulean—are of the "Drift" or "River-drift" type, so called because they are found in the drift of gravels carried down and deposited on terraces on the sides of valleys when the river-beds were in process of formation. The implements of the remaining periods—Mousterian, Aurignacian, Solutrian, and Magdalenian—belong to the "Cave" type or series, as they have, in France at least, usually been discovered in caves which have served as the dwelling-places of Palæolithic peoples. In technique the distinction between the "Drift" and the "Cave" series of implements lies in the fact that, while the "Drift" implement has been shaped by striking flakes from a block of flint, the "Cave" type—e.g. the implements from Le Moustier with which the implements from the Suffolk Chalky Boulder Clay are comparable—are fashioned from the flakes themselves which have been struck from a block of flint or "core."

The great interest of Mr. Moir's discovery lies in the fact that implements of Mousterian type should be found in the Boulder Clay. Geologists have, as a rule, taken it as axiomatic that the earliest implement-bearing stratum is the Boulder Clay, and it will be remembered that the investigations made by the Committee of the British Association at Hoxne in Suffolk, of which such distinguished authorities as the late Sir John Evans and the late Mr. Clement Reid were members, showed that on that site, at least, flint implements of the "Drift" type were later than the Boulder Clay, while the borings carried out by the Committee furnish evidence of two warm periods intervening between the gravels in which the implements were found and the Boulder Clay, which is a deposit of Glacial Age. On the evidence from Hoxne, implements of the "Drift" type would therefore appear to be of Post-Glacial Age.

In France the relative age of the different classes of Palæolithic implements has been established with some precision. Implements of Le Moustier type come third in point of time, following the two series belonging to the "Drift" type from Chelles and St. Acheul. In England the relation of the "Drift" and the Le Moustier types is not so clear; but on the basis of analogy, it might be presumed that "Drift" implements precede the other types. It may be noted in parenthesis that Mr. Reid Moir, in his recent publication "Pre-Palæolithic Man," after a careful analysis of the technique of Palæolithic implements, arrives at the conclusion that the "Drift" implement made from a core precedes the Mousterian implement, which was made from a flake. Archæologists are therefore faced with this difficulty—that implements apparently belonging to a later stage of culture have been found in a deposit which, in another locality, precedes implements of an earlier type by a very considerable period of time.

If, therefore, Mr. Moir's implements belong to the Mousterian phase of culture—they are certainly of Mousterian type, and some exhibit a form of patination usually considered to be characteristic of the Le Moustier period—and no doubt can be raised as to their occurrence in Boulder Clay, the question resolves itself almost entirely into one of the geological evidence. Prof. J. E. Marr, F.R.S., who has examined the pits, states that the Boulder Clay is *in situ*. It would appear, therefore, that the question before the geologist is whether the Chalky Boulder Clay is everywhere of the same age, as is generally stated. If it is, is it possible that the evidence obtained by the Committee at Hoxne was untrustworthy, and that it was misled as to the true character of the deposit identified as Boulder Clay? Some geologists would maintain that the finding of Mousterian implements in Chalky Boulder Clay is evidence of late date, and that this view is supported by the palæontologists, who hold that an examination of a continuous series of the fauna of this period shows no signs of an alternation of warm and cold phases, but that the strata with remains of a cold period are always on top, and therefore latest in date. A careful study and re-examination of the question of the Boulder Clay generally and of the deposits at Hoxne would appear to be necessary before any certain conclusion is possible.

Mistakes[1]

THIS is a straightforward book with only one difficult word, and that is in the title. It contains an exposition of Dr. Freud's views on the psychology of lapses and of mistakes. It is a work of interest to everybody, because it deals with mistakes which we all make. In this book, which is the best known of all Freud's writings, an attempt is made to explain some of the little slips we make in writing and speaking, why it is we forget proper names and foreign words, why we try to conceal some of our memories, and why, when meaning to do a thing in one way, we do it, almost in spite of ourselves, in another. Everyone is familiar with these occurrences. What is the cause of them ?

An ordinary person would imagine that the main cause of all our daily slips and errors is that we are tired. If we sign the name of the friend written to at the end of our letter to him, instead of our own, we ascribe the slip to the fact that we are not sufficiently alert ; we are mind-wandering. Freud's view of the matter is, however, different. The mistake, in his view, is symbolic of hidden motives which are at work in the mind of the man who is making the mistake. The slip gives him away. To anyone trained to see it reveals more than the man meant to reveal. The slip enables the psychologist to brush aside the open intention of the man as being false, and to get at the true underlying motive.

An example taken from p. 102 of the book may help to make this point clear :

" A wealthy but not very generous host invited his friends to an evening dance. Everything went well until about 11.30 p.m., when there was an intermission, presumably for supper. To the great disappointment of most of the guests there was no supper ; instead, they were regaled with thin sandwiches and lemonade. As it was close to election day the conversation centred on the different candidates ; and as the discussion grew warmer, one of the guests, an ardent admirer of the Progressive Party candidate, remarked to the host : 'You may say what you please about Teddy, but there is one thing—he can always be relied upon ; he always gives you a *square meal*,' wishing to say *square deal*. The assembled guests burst into a roar of laughter. . . ." Here the error of speech revealed the speaker's mind with full comic effect. He had no intention of being openly rude. He was so in spite of himself.

An example of an action erroneously carried out will now be quoted from p. 179 :

" The use of keys is a fertile source of occurrences of this kind, of which two examples may be given. If I am disturbed in the midst of some engrossing work at home by having to go to the hospital to carry out some routine work, I am very apt to find myself trying to open the door of my laboratory there with the key of my desk at home, although the two keys are quite unlike each other. The mistake unconsciously demonstrates where I would be at the moment.

" Some years ago I was acting in a subordinate position at a certain institution, the front door of which was kept locked, so that it was necessary to ring for admission. On several occasions I found myself making serious attempts to open the door with my house key. Each one of the permanent visiting staff, of which I aspired to be a member, was provided with a key to avoid the trouble of having to wait at the door. My mistake thus expressed the desire to be on a similar footing and to be quite 'at home' there."

Freud's point, then, is that these slips are not accidental at all, but that in every case they can be explained ; and usually the explanation can be given in terms of the secret feelings and wishes of the person making the mistake.

This book is full of anecdotes about slips made by people, and each of these is ingeniously analysed by the author along the lines stated above. Some of the explanations will appear to the reader to be somewhat far-fetched, but, of course, that need not prevent them being the true ones. What the book does impress upon one is that we attribute far too many errors to accidental and extraneous causes. As regards our own mistakes, if only we have the wit to examine ourselves, we may usually find some explanation which lies not outside but within ourselves.

To say that every mistake is symptomatic of unconscious secret wishes is, of course, going too far. If, for example, in writing to a lady I refer to her letter as " your precious letter " instead of " your previous letter," this need not necessarily indicate any hidden state of feeling which I may have for the lady. It happens that *c* and *v* are next one another on my typewriter, and I happen merely to have struck the wrong letter. It is useless to assert in reply that something in me made me strike the *c* instead of the *v*, because I find that as often as I strike *c* for *v* I strike *b*, which is the letter on the other side of *v*; and as that gives a meaningless word when I try to type "previous," I conclude that my mistake is purely accidental, and not in the least deliberate.

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[1] *Psychopathology of Everyday Life.* By Prof. S. Freud. Sixth Impression. (Fisher Unwin, 12*s*. 6*d*. net.)

An extreme case—it is not given in this book—is that of the billposter who fell off his ladder into a bucket of whitewash. If we assert that this was not accidental, we are led to believe that the billposter had a secret desire either (*a*) to end his life, or (*b*) to whitewash himself or his character. Now, the billposter fell because the rung of the ladder broke, and we need not assert that something in the hidden consciousness of the man knew this, and made him stand on the weakened rung.

On the other hand, many a far-fetched explanation may be a true one. Only this morning a friend, in describing Mr. Maynard Keynes' book on the *Economics of the Peace*, said: "It is very good, but it has one or two *ships*." He meant *slips*. Now, Freud would say there is a real explanation for this, and explanation there is. For this friend of mine, when speaking of the book, was thinking of the author's position, which is Fellow of King's, and *kings* was closely associated in his mind with *ships* by those lines of Lewis Carroll (quoted by him erroneously):

> "Shoes and ships and sealing-wax
> And cabbages and kings."

It may seem a long way round, but it is nevertheless, as my friend agrees, the correct solution of the difficulty.

So what we say of this book is that it is very stimulating and very interesting. A reader need not swallow Freud's theories whole. But there is a lot in them, and a good deal of it is great fun.

P. K. FORBES.

The Idolatry of Science[1]

MR. COLERIDGE has written a very amusing book; indeed, since Mr. Stephen Leacock attacked the Classics in his comic article on "Homer and Humbug" we have rarely read so amusing an "attack." Mr. Coleridge's general thesis is that, on the whole, science has had a bad influence on the world, and that really it is high time that some responsible person or body of men protested against the blind worship which it receives everywhere. It simply isn't

[*Continued on p. 120*

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[1] *The Idolatry of Science.* By the Hon. Stephen Coleridge. (John Lane, 3*s.* 6*d.* net.)

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good enough. By science he means something which is "entirely distinct from, and opposite to, poetry, letters, oratory, history, and philosophy; something that has no relation to, or connection with, the emotions, or with the character of man; something wholly unconnected with conduct; something with which the principles of right and wrong have no concern." By scientists he singles out men like Darwin, Newton, Lord Merchiston (the inventor of logarithms), Lord Lister, and Dr. Flexner. These people and others, and their views, are discussed at length.

It is well that Mr. Coleridge is an open and courageous enemy of science. He does not tolerate it, wishing in his heart that it had never existed. He does not content himself by damning the thing with faint or with patronising praise. He hates it. He sees in it the remorseless enemy of mankind, a something which destroys simplicity, beauty, and gentleness, something which restores barbarism under the mask of civilisation. He wishes it had never come into being. His attitude at times is rather like that of Arnold of Rugby. "Rather than have physical science the principal thing in my son's mind," wrote he to a friend, "I would gladly have him think that the sun went round the earth, and that the stars were so many spangles set in the bright blue firmament." And Hegel too adopted this position. In attacking Newton's theory of the movement of planets according to universal gravitation, that philosopher said that the planets were not pulled this way or that way like so many stones, *but that they move of themselves in their orbits like the blessed gods!* But Mr. Coleridge goes further than Arnold and Hegel, further, too, than the poets of two hundred years ago, who poked fun at science as it then existed. He has no use for science at all. He longs for the good old days before Messrs. Watt and Stephenson (as he calls them) got busy on the steam-engine, before factories polluted our air, before telephones took away the last vestige of our privacy, and before those infernal doctors began inoculating their patients, and experimenting with animals.

Says Mr. Coleridge:

> "How am I advantaged as a man, and as one who loves his country, by getting to Edinburgh from London in eight hours, having seen nothing; instead of getting there in three or four days, and seeing all the loveliness of the countryside, the peasants happily working in the fields, the sweet, unconscious beauty of the villages, the parks and comely mansions with their stately gates on the old high-road, the venerable churches with their ivy-covered rectories hard by, the quaint red brick almshouses, founded ages ago by pious benefactors, with their placid old inmates sitting out in the sun, all eloquent of the blessed repose of the quiet life?"

Hear, hear! we say to this. It is all very delightful, and so far we agree with every word he says. It calls to mind Mr. Chesterton's mediæval peasant, or Tom Pinch's ride to London in *Martin Chuzzlewit*, or Goldsmith's "Sweet Auburn, loveliest village of the plain." Yet the remedy for avoiding the rush to Edinburgh is so simple that it must have occurred to Mr. Coleridge. Go by motor-car. And here, I confess, I am wrong. Mr. Coleridge is not against *everything* scientific. He excepts the bicycle and the motor-car. They are all right, but who on earth wants to know about conics and chemistry, or about wireless and medicine? The folk in the good old days got on without them: why cannot we? Is it any use telling immortal souls that centrobaric dispositions are kinetically symmetrical? Are we really any the better for rushing about in tubes, or being shot up in elevators, or making cotton pants by machinery? The author thinks not, and he is entitled to his opinions. Of course, there is no harm in knowing something about astronomy or how to build bridges and bore tunnels, and how the common-suction pump works, and how many blue beans make five. This, however, is not wisdom. Why put on airs because we know these things? Anyone who is awake and not mentally deficient can acquire these facts in a few hours. But wisdom—ah! wisdom is a plant of slower growth.

Mr. Coleridge is most interesting and most amusing when he is attacking. Now, we all love an attack. It doesn't matter specially what it is that is being attacked, so long as it is an attack, *and we are the spectators.* How annoying it is to find that the street fight has concluded just a few moments before our arrival! Mr. Coleridge's special "stunt" is to poke fun at the apparent weaknesses of men of science. The editor of a scientific journal prints two absolutely contradictory statements on opposite pages of his magazine, and Mr. Coleridge does not let us forget it; a meteorologist says, in an unguarded moment, that "the sun itself does not give out heat," and we are treated to a humorous commentary thereon; a chemist describes the preparation of ortho-cyano-benzyl-hexamethylene-tetraminium chloride, and Mr. Coleridge administers to him a dialectic upper-cut for not spelling it more shortly.

He thinks, too, that scientists are arrogant. Boyle, Cavendish, Russel Wallace, Faraday, Clerk Maxwell, Silvanus Thompson arrogant! Yes.

> "They are all illustrious and world famous, they pelt each other with degrees and diplomas, the whole country rings with their mutual hosannas, and the fountains of honour play upon them like a fire-engine on a conflagration."

He considers that the title of "Professor," except when assumed by conjurers, jugglers, and tumblers, stamps a man as narrow, prejudicial, inaccurate, ignorant, and dangerous.

It is a little difficult at times to know whether Mr. Coleridge is serious or not. One would almost imagine from the way he writes that he disapproves of inoculation and of vivisection. We like especially his amusing mock picture of typhoid germs. It is so good that we are sorry that he has not prepared more illustrations for us. May we help him here? On p. 64 the author says, "Sir Joseph Lister was raised to the peerage in a halo of antiseptic spray." What a grand opportunity that is for the nimble pencil of Mr. Heath Robinson! Again, on p. 56 we are told that the scientist

> "will not argue or listen to argument; he brings forward no reasonable evidence, and will not attend to reasonable evidence brought before him by others. He is a man of science, he peddles in a laboratory, he asserts, and when he speaks let no dog bark!"

An illustration of this passage by Mr. Max Beerbohm would absolutely make the second edition. The scientist on the left of the picture carefully brushing aside every argument but his own, and busily peddling; on the right six dogs straining at the leash, and being just restrained from barking by the warning finger of a boy. What a chance for the artist! It is too good to miss.

It is a pity that Mr. Coleridge allows his views to run away with him at times. With many Englishmen a specialist training leads to what seems to us a narrow view. One man sees the cause of war and misery in "the lawyers," another in "the politicians," a third in "the clericals," a fourth in "the international Jew financier." Mr. Coleridge thinks it is science. But these are all bogey-men. With his main point that the teaching of science without an accompanying training in other subjects, in character, and above all in religion, is dangerous, we agree. But what sensible man or woman would deny this? Yet humour, whether conscious or unconscious, is so rare these days that we welcome it wherever we see it.

A. S. RUSSELL.

PROFESSOR J. B. WATSON, of the Johns Hopkins University, is the author of a new book on Psychology. It is written for University students, and the subject is treated in a thoroughly scientific manner. The ordinary reader may consider parts of it stiff, but the psychologist will find in it a fresh and unconventional treatment of his subject.

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Reviews of Books

Silvanus Phillips Thompson, D.Sc., LL.D., F.R.S.: His Life and Letters. By JANE SMEAL THOMPSON and HELEN G. THOMPSON, B.Sc. (Fisher Unwin, 21s. net.)

Professor Silvanus Thompson was born in 1851 and died in 1916. Those sixty-five years of his were crowded ones, for he was a man of restless activity. He made a name for himself first and foremost as a science teacher. He made important contributions to our knowledge of electricity, optics, and electro-technology. He was the author of several very clearly written textbooks. He was the biographer of Faraday and of Lord Kelvin. He was, in addition, a man of varied tastes and hobbies. He was a member of the Society of Friends. He loved the scientific literature of the sixteenth and seventeenth centuries. He drew in black-and-white, and painted in water-colours. A man of varied interests, the chief of which was in Science.

We are indebted for this interesting biography to his wife and his daughter. They have given us a happy and intimate account of the professor. The material on which the book is based has been well used, and the style and the setting forth is good. Very wisely the authoresses have arranged their material, not in strict chronological order, but according to subject. This helps to make a book easy to refer to, and easy to read. In the case of scientific biography it enables the non-technical reader to read what interests him most. The more technical details, being grouped in one or two chapters, may, if desired, be skipped.

Silvanus Thompson was a familiar figure in scientific circles in London, because from 1885 till his death he was the principal of Finsbury Technical College. The Royal Society and the Royal Institution saw much of him, and popular audiences at the latter heard with delight his expositions of scientific knowledge. He was an exceedingly good lecturer. No trouble was too much for him, no experiment too difficult. It was all worth while if it would serve to make his lectures clearer. Better understood, better remembered.

He began research at Bristol, where in 1876 he had been appointed Lecturer in Physics at the newly founded University College, and his first paper on phenomena connected with induced electric sparks was printed in the same year in the *Philosophical Magazine.* The long list of published papers which is given in the appendix of the biography testify to his originality, his versatility, and to his capacity for work. Like Lord Kelvin, he had that wonderful power of taking the most extraordinary interest in anything that was new. If he had an interest in a thing, it was a keen interest, an enthusiasm. All his research was good work, though actually, as it happened, none of it became epoch-making. Once, indeed, he came near to a very big thing, but someone else arrived independently at substantially the same results a little before him. In 1895 the discovery of X-rays by Professor Röntgen of Würzburg made a tremendous sensation. A few months later, Thompson, while working with X-rays, found that uranium nitrate had an action on a photographic plate in circumstances in which X-rays had not. This was something new, and he wrote immediately to Stokes, then President of the Royal Society, about it. Alas! Becquerel of Paris had anticipated him by a few weeks. This was the first discovery in the science which later became known as radio-activity.

In 1881 Thompson's book *Elementary Lessons in Magnetism and Electricity* was published. This was a very good textbook. It has had a wide sale, and has served more than one generation of students. Two years later he wrote an account of Reis, the inventor of the telephone. The invention of the telephone is usually ascribed to Dr. Graham Bell, but in this book Thompson showed that, sixteen years before Bell's invention was made known, a Philipp Reis of Frankfort made an instrument for the express purpose of transmitting speech by electricity, and called it the "Telephon."

Thompson was very keen that honour of priority of invention should go where honour was due, and several controversies on this point in which he took part, especially in connection with the invention of the dynamo and of wireless telegraphy, are touched on in the work under review.

In 1896 appeared *Light Visible and Invisible,* a popular and well-written book. Two years later appeared his life of Faraday. This is considered to be the best life of Faraday. It was a success, and Thompson used it later on as a testimonial in his favour to obtain permission from Lord Kelvin to write his biography. Kelvin granted this request at once, and gave Thompson several "sittings," at which scientific topics were discussed, and questions were asked and answered to help him in this work. The Kelvin biography appeared in two volumes in 1910.

In the same year there was published anonymously *Calculus made Easy,* by F. R. S. Thompson wrote this, but the authorship was not disclosed till after his death. The idea of this book was to make the main principles of the Differential Calculus plain to many who had hitherto been rather frightened by it. The book was written in a very amusing colloquial style, and in the Prologue he wrote:

"Being myself a remarkably stupid fellow, I have had to unteach myself the difficulties, and now beg to present to my fellow-fools the parts that are not hard. Master these thoroughly, and the rest will follow. What one fool can do, another can."

Everyone enjoys a "leg-pull," and much wise and clear exposition went with this one. The book was an instant success, and justified completely the somewhat novel and ingenious way of presenting a difficult subject A few guessed who the author was, but many who should have been able to didn't.

For an account of Professor Thompson's excursions into the scientific literature of the sixteenth and seventeenth centuries, and particularly of his devotion to Gilbert, the father of magnetism, we must refer the reader to the biography.

Two books by Silvanus Thompson deal with his religious faith. The *Quest for Truth* appeared in 1915, and *A Not Impossible Religion* posthumously in 1918. His forbears were Quakers, and he remained a Friend all his life.

A. S. R.

Can we Set the World in Order? By C. R. Enock, C.E. (Grant Richards, 1916, 3*s.* 6*d.* net.)

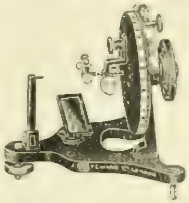
Mr. C. R. Enock, a traveller of wide experience and a well-known writer on South America and other tropical lands, has written a most thoughtful and stimulating volume which should be studied by everyone interested in the problems of home and imperial administration. He makes an appeal to the constructive sense of man to see economic problems in their wider bearings, the antithesis of the opportunist policy of the time. Mr. Enock sees the world in a state of chaos, but believes that it is possible to reach conditions of reasonable economic equilibrium, in which the needs of the individual and the community are established in permanent security. Progress so far has been too exclusively measured in terms of natural wealth and pleasure. The result is that the natural resources of the world have been ruthlessly exploited in the race for wealth. This is not only economically unsound, but is not conducive in the long-run to the well-being of all classes and all races. The book must be read for a full understanding of the closely reasoned argument, which is copiously illustrated from the author's wide experience. Briefly, he presses for the need of a science of corporate life which must be constructive rather than observatory. Economics are too academic to get into real touch with realities, and geography, although far more practical, is too deeply imbued with commercialism. Mr. Enock looks to a development of the science of human geography on constructive lines—in other words, the grasp and application of its principles—as a guide to the statesman and administrator.

R. N. R. B.

The Quantitative Method in Biology. By Prof. Julius Macleod (University of Ghent). (Manchester University Press, 15*s.* net.)

In a volume suggesting the school of De Vries' Mutations theory, the writer emphasises the great natural capacity of plant-forms for variation due to inherent *plasticity*; the remarkable changes in many forms under cultivation, according to him, being merely the expression of this natural property, more in some than in others, and thus revealed for the first time. The difference between one species and another is conceived on a purely chemical basis, and is to be estimated on quantitative lines by precise measurement of the range of so-called *primordia*. The latter term, usually used in botany in an entirely different sense, is perhaps unfortunate; it merely expresses what is loosely known as a factor, and the organism is viewed as a collection or *combination* of factors. In Spirogyra, for example, such functions as the length and breadth of a cell-unit are "primordia." The importance of getting adequate data by measurement for every individual factor of an organism, or for a series of allied

[*Continued on p.* 124



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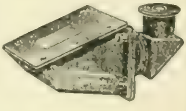

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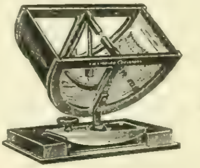

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ones, is insisted on, as indispensable for the accurate delimitation of species in systematy; maxima and minima for the primordia being regarded as "specific constants." There is no objection whatever to this being done; the fact that it has not been generally done in the past is merely a question of labour and the immense amount of available material in even a small flora. The field is quite open to anyone who cares to spend his life in the acquisition of such laborious data. What one wants to know, of course, is what good will come of it. Extended examples are given of the possibilities of variation curves, variation "steps," and "gradation curves"; the combination of such data, constituting a quantitative diagnosis of a species, is defined as "Bertillonage"; but the application of the method for the determination of accepted species is not particularly convincing; it being sufficiently obvious that what are termed *species* by a systematist are still empiricisms wholly lacking any precise standard of reference. It is in thus drawing attention to the general rottenness of the foundation of systematy, as also to the fact that the ordinary collector has but the vaguest notion of the range of type in the forms he deals with over only a small area, that the work attains, perhaps, its greatest value. The text is plentifully decorated with italics and headings in large capitals, and under other conditions, possibly, might have been published in German.

Economics for To-day. By ALFRED MILNES, M.A. (J. M. Dent & Sons, 3*s.* 6*d.* net.)

With certain reservations we can recommend this book cordially to readers who wish to make a first acquaintance with economics. It is clearly written, and is furnished in many places with good illustrations. It should thus enable a young student or a beginner to obtain a grasp of the outlines of the subject without having a teacher at his side to explain the difficulties of the subject to him. But reservations must be made with regard to the chapter on the Inland Market, in which the author is not so happy in his exposition. Thus there is a point on p. 113 about the demand for money; whether this refers to the quantity theory of money in its crudest form, or to something else, it is difficult to say, and no explanation is offered. Again, about the same place, use is made of three expressions, "demand-price curves," "demand-value curves," and "quantity-value curves," without any indication of the differences between them, if any; which is somewhat confusing, especially as none of these expressions are at all commonly used by economists, let alone general readers. The reference (p. 122) to "various prices" at which demand and supply can balance is also not very clear.

Apart from the ambiguities of this particular chapter, there are one or two slips which should be corrected in a subsequent edition. At present, thanks to the recent epidemic of amalgamations, there are eleven and not eighteen clearing banks (p. 217). Also, it is hardly correct to say that the Bank Charter Act has been suspended four times (p. 220)—it was only in 1857 and in 1914 that notes were issued in excess of the statutory limit. The price of the four-pound loaf in England before the war was nearly sixpence, so that the statement (p. 225) that it sold "for little more than threepence" hardly conveys the correct impression.

In spite of these small defects, Mr. Milnes's book is a welcome addition to the literature of elementary economics, and is adapted to the needs of the general reader as well as those of young students. The publishers are to be congratulated on producing the book in a presentable style at the—to-day—very moderate price of 3*s.* 6*d.* net.

D. K.

Evening Play-Centres for Children. By JANET PENROSE TREVELYAN. (Methuen, 5*s.* net.)

This is a very well written book on a subject that is of great interest to everyone who has the welfare of the poorer children of our towns at heart. It should interest particularly social and settlement workers.

It is now twenty-two years since the first play-centre for children was opened at the Passmore Edwards Settlement in Bloomsbury. Mrs. Humphry Ward was the pioneer of the movement, and to her courage and energy and that of her helpers is due its remarkable progress. In this book Mrs. Trevelyan gives a history of the movement, and an account of its principles, objects, and results. From the small beginning, the movement has grown till it now embraces 300 centres in the provinces, and over 30 in London.

These centres, needless to say, have had good influences, not only on the children attending them, but also on their parents.

Vacation schools and organised playgrounds are also described with inside knowledge; and, in appendices, details dealing with the formation of play-centres, and descriptions of nearly a hundred suitable games, are given.

Mrs. Humphry Ward contributes a preface.

P. K. F.

Meteorology for All. By D. W. HORNER. (Witherby, 6*s.* net.)

The Principles of Aerography. By PROF. A. MCADIE. (Harrap, 21*s.* net.)

Both these books are good ones, for by reading either of them through one gets a very good idea of the subject. Both are informative. By means of facts, tables, diagrams, and photographs, a fund of information is conveyed to the reader. Both are written in an interesting manner, so that the general reader can read right through without being bored.

Mr. Horner's book is written for a wider audience than Prof. McAdie's. It is meant, as the title implies, for everybody. Not for everybody, of course, but for all those who wish to have acquaintance with the methods of forecasting the weather, and who are interested in clouds, snow, lightning, and wind, and the why and wherefore of the phenomena connected with them: who, instead of cursing the "Clerk of the Weather" as a fool, and believing that the prediction of weather is impossible, want to know how far one can predict the vagaries of the weather, and along what lines the solution of the outstanding problems of the science is to be sought. Mr. Horner gives a good account of what has been done by the meteorologists, and also indicates much that has still to be done.

The instruments used in meteorology, the thermometers, barometers, hygrometers, rain-gauges, sunshine recorders, etc., are well described. It is a pity that the illustrations have not come out better. They are rather small, and some are hardly clear enough; but reproduction of photographs and diagrams, except in an expensive book, is not an easy matter at the present time.

We recommend this book.

. . . . .

Dr. McAdie is the Professor of Meteorology at Harvard University. This book of his is a joy. No one can read it without feeling that Meteorology, or Aerography as it is called here, is a great subject. This is a book for the student—that is to say, a reader is supposed to be equipped with a sound and comprehensive knowledge of elementary Physics; but the general reader may read most of the book without being taken appreciably out of his depth, and as a work of reference on the subject of the weather it is admirable. The importance of this book lies in the fact that the author has put all the latest information on the subject into it, and that it is exceptionally well illustrated. He advocates scrapping the old system of units in force, and bringing in without further ado the C.G.S. system. He believes in classifying clouds according to their origin rather than their appearance. Some of the subjects dealt with, which are not included in the ordinary textbook, are studies of air-flow at different levels, studies of ice-storms, snowfall equivalents, and water-supply, charts for airmen, variations of ocean currents, and recent knowledge of solar phenomena.

A guinea for a work of three hundred pages seems a stiff price, but the book is most beautifully produced in every way. There are more than fifty photographs, and they are all very clear, so too are the diagrams and charts. The man who writes it knows thoroughly what he is talking about, and he knows how to write, so altogether a charming book results.

The Development of the Atomic Theory. By A. N. Meldrum, Fellow of the Bombay University. (Oxford University Press, 1s. 6*d.* net.)

Dr. Meldrum has given us an interesting contribution to the history of Chemistry. He shows, among other things, that Dalton, who brought out his famous Atomic Theory in 1803, was forestalled by one Higgins by no less than fourteen years. Higgins's ideas about atoms, unfortunately for him, fell on a somewhat heedless world. There is no suggestion in this essay that Dalton plagiarised from Higgins. Both, starting from Newton's doctrine of an elastic fluid, reached essentially the same conclusions, only Higgins the unknown was fourteen years ahead of Dalton.

Laboratory Manual of Elementary Colloid Chemistry. By E. Hatschek. (Churchill, 6*s.* 6*d.* net.)

This is a book we can thoroughly recommend. It is, indeed, almost a necessary book for honours students of Chemistry, because some knowledge of colloids is nowa-

[*Continued on p. 126*

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days an indispensable part of a chemist's equipment. This is the first book that has come under our notice which concerns itself exclusively with instructions for carrying out experiments in this branch of Chemistry, and the author is to be congratulated on his work.

An acquaintance with the subject such as may be obtained from the author's *Introduction to the Physics and Chemistry of Colloids*, or from Dr. Lewis's *Physical Chemistry*, vol. i, is presupposed. The experiments described are, generally speaking, the simplest ones, and, wherever possible, those which involve the smallest outlay of apparatus and material. The instructions are clear, simple, and sufficient. We have tried a good many of the experiments described, and find that they work all right.

References to recent literature and to more advanced portions of the subjects touched upon are given at the end of each section. The diagrams are clear, and the form of the book is good. A. S. R.

Practical Histology. 3rd Edition. By Prof. J. N. Langley, Sc.D., F.R.S. (Heffer, 10*s.* 6*d.* net.)

Handbook of Physiology. 15th Edition. By Prof. W. D. Halliburton, M.D., F.R.S. (John Murray, 18*s.* net.)

It requires no words from us to commend these popular books, but mention may be made that new editions of both, having been called for, are now available. In the *Histology* a number of changes have been made, some due to recent improvements in methods, some to obviate which the experience of the class-room has shown to be difficulties felt by students, and a few to bring descriptions in accord with present nomenclature. In the *Physiology* no fundamental alterations have been found to be necessary. Such as have been made are of the minor kind necessary to bring the work up-to-date.

The Practical Book of Interior Decoration. By H. D. Eberlein, A. McClure, and E. S. Holloway. (Lippincott, 35*s.* net.)

This book is quite different from the little volume in leather which one produces from one's pocket in the bus, or at the theatre between the acts. For in weight and girth it is immense, formidable, Falstaffian. But then it costs thirty-five shillings, and it has three authors, and it deals with a big problem. And it is worth the money.

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The second part deals with practical decoration and furnishing, discussing such subjects as colour-schemes, floors, walls, pictures, the arrangement of furniture and artificial lighting. The chapter on colour and colour-schemes is perhaps the best in the book, and will be found most useful by every reader.

The third part deals with the problem of mixing styles in decoration and furniture of different periods, and the true path is clearly indicated.

This book is the most useful and comprehensive one on the subject that we have seen.

Other Publications Received

(*We hope to deal with several of these in future issues.*)

Intermediate Textbook of Magnetism and Electricity. By R. W. Hutchinson, M.Sc., A.M.I.E.E. (University Tutorial Press, 8*s.* 6*d.* net.)

Peat Industry Reference Book. By F. T. Gissing. (Griffin, 7*s.* 6*d.* net.)

By Nile and Tigris. By Sir E. A. Wallis Budge, M.A., Litt.D. (John Murray, 2 vols, £3 3*s.* net.)

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Wild Life in Canada. By Capt. Angus Buchanan, M.C. (John Murray, 15*s.* net.)

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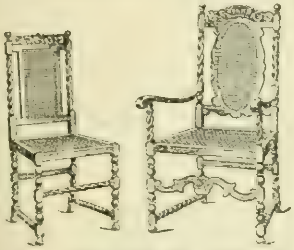

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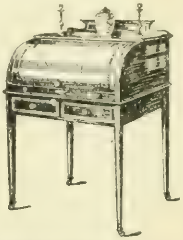

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DISCOVERY

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Editorial Notes

Those who are in favour of changing our present coinage system for a decimal one will not view with especial favour the recent report of the Royal Commission on Decimal Coinage. It is not a unanimous report, but two-thirds of the members of the Commission are against making a change in the present system. It is felt that the obvious advantages to be gained by changing to a decimal system—as, for example, in keeping accounts—are outweighed by the disadvantages arising from the loss of convenience of the present system for other purposes. If a change must be made, the Commission thinks that the pound-mil scheme is the best.

In this scheme the pound sterling remains as in the present system. It is not altered in any way. The farthing is altered slightly in value, however, so that instead of 960 there are 1,000 of them in the pound. These new coins would be called mils. One hundred mils would be equivalent to the present florin, and ten of them to a new coin approximately equal to twopence-halfpenny.

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There is no question that, if everybody in the country would agree to drop the present system, forget all about it, adopt a decimal system and acquire ability in using it in a very short time, the change would be one for the better. But it is, of course, a much simpler thing to condemn the present system and to devise a decimal one, than to suggest a means of "switching over" from the old to the new without causing inconvenience that in many cases would be little short of chaos. It is a change, however, that ought to be made sometime, and it appears that the adoption of a decimal system of weights and measures throughout the country would prepare the way to some extent for the adoption of a similar system of coinage.

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Direction-finding by wireless waves has now been brought to a considerable degree of perfection. The apparatus used for this is called the wireless direction-finder. When a ship loses its way through fog, or owing to any reason, this instrument provides a means whereby the captain can get into touch with wireless stations on land or on other ships, and know in a few minutes just where he is. Recent Admiralty orders have provided for the establishment of wireless stations on the coast, which will work in conjunction with these direction-finders. The Marconi direction-finder not only receives wireless signals; it also indicates the direction of the sending station.

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It has a working range of from 200 to 300 miles as ordinarily employed, and it is unaffected by weather conditions. In wireless telegraphy, as is well known, the signals are transformed into sounds by the receiving gear, and these are heard by the receiving operator, who wears a telephone headpiece for the purpose. If we imagine ourselves "listening in" in this way on board ship in the English Channel, we should hear all the ships and shore stations in the neighbourhood that happen to be working at the moment. By means of the direction-finding apparatus a bearing to the source from which the wireless waves are coming may be obtained. By finding the bearings to two or more stations whose positions are known, the ship's position on the chart may be found. Suppose, for example, that a ship coming up the English Channel in foggy weather is somewhere to the west of the Channel Isles. It could ascertain its position by taking bearings on Land's End and Ushant, and a third reading on Cherbourg provided that a check on these observations is required. Under the circumstances the direction-finder indicates that Land's End is somewhere on a line making an angle of [illegible] degrees with the fore and aft line of the ship, and the corresponding angle for Ushant is [illegible] degrees. The direction in which the ship is heading at the moment of the experiment is known, since it is given by the compass, and it is therefore not a difficult matter to combine observations and set out the ship's position on the chart.

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It may be mentioned that it is not always necessary to ascertain the ship's position, the direction of a known point from the ship being often all that is needed. In such cases one observation only is necessary, as, for example, in determining whether a ship's course will take it inside or outside a lightship or isolated lighthouse. A wireless signal from one or the other will settle the question almost as certainly as though the lights were visible. Again, when the ship is about to enter harbour, signals from a station in the harbour will show immediately if the ship has drifted to one side of the entrance.

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An interesting point bearing on the truthfulness of novelists is dealt with by Mr. H. M. Paull in a recent number of the *Fortnightly Review*. Mr. Paull points out that it is a not infrequent practice for an author to write an introduction to his story in which he gives deliberately an erroneous account of its origin. Defoe, for example, asserted his belief in the preface to his *Journal of the Plague Year* that the work was really written by a man who continued all the time in London while the Plague was raging. As Defoe and no other was the author, and as he was only five at the time of the Plague, it is evident that his idea of truth is—well, is simply not truth at all. Scott, Goldsmith, Horace Walpole, and in more recent times George Gissing are also cited as sinning in this way. It is, however, not a common practice. Those who write these fictitious prefaces generally do so for reasons similar to those which lead writers to adopt *noms-de-guerre*, but in a few cases the motive is less worthy. Some authors find that a certain kind of showman's lie in the preface helps the sale of their books, others do it for the pure intellectual joy of lying.

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In subsequent numbers of this journal we hope to make a new departure in having pictures and diagrams illustrating the articles. In the next number we hope to print articles on the Planets, the Roman [illegible] in Crete, the Origins of Mexican Mythology, the [illegible] of the [illegible], Aviation and the [illegible] Sugar Beet and Industrial Alcohol, and on other subjects.

The Concert of Europe in the Nineteenth Century

By F. J. C. Hearnshaw, M.A., LL.D.

Professor of History in King's College, University of London

(Continued from April No., p. [illegible])

IV

ALTHOUGH by 1830 the Quadruple Alliance was quite broken up, and although its members found themselves ranged in antagonism to one another on several fundamental issues, yet even then the tradition of common interests and common action established during the Napoleonic era and the period of the Congresses was never again wholly lost. From 1830 right down to 1914 the Concert of Europe, albeit it ceased to give continuous performances as during the years of its glory, never went entirely out of existence. On the contrary it maintained a useful vitality; it enlarged its membership; it made it a particular business of its own to deal with the Eastern Question and other acutely controversial problems of international politics; it succeeded in preventing several wars; it managed to effect more than one important world-settlement.

First, as to its members. The four Powers of the old Quadruple Alliance continued to occupy the position of prime importance. Next, and almost equal to them, came France.[1] Italy was admitted in 1859. In 1871 Prussia brought the newly constituted German Empire with her into the innermost circle of the Concert, and began to claim in her name a hegemony. For purposes extra-European—with which we are on this occasion not concerned—the United States and Japan began to be included. When problems of world politics came into question, the States of Asia and Southern America were increasingly asked to send delegates. Thus at the first Hague Conference twenty-six Powers were represented; at the second, forty-two.

It did not prove easy for Powers so numerous and so diverse to co-operate for common ends. Each of them had its own particularist interests which it pursued in preference to those of the community of States. These particularist interests tended more and more to clash with one another, especially in the spheres of economic and colonial expansion. The associated Powers, moreover, represented and embodied conflicting political principles, and it became increasingly hard for those which stood for democracy and nationality to work in harmony with those that were inspired by ideas of military autocracy and world dominion. From 1871 in particular, the Prussified German Empire, with its ambitious aims and its intolerable manners, became an almost insuperable obstacle to any cordial co-operation among the Powers, or to any continuance of honest understanding and genuine goodwill.

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[1] Under the Emperor Napoleon III indeed France for a few years, especially [illegible], rose to a position of ascendancy.

It is remarkable that in such circumstances the Concert of Europe could continue to exist, and still more that it could do any good and effective work. That, in spite of all, it did exist and that it achieved some notable successes is eloquent testimony to the sense of solidarity which still held the Continent together, and to the skill and patience of the diplomatists who accomplished so much in conditions so unfavourable. To enter into details concerning its operations would lead us too far afield into the minutiæ of European history. It must suffice to say that on at least ten occasions the Powers acting in concert dealt with and settled (if only provisionally and temporarily) questions which, apart from their action, would in all probability have led to a Continental conflagration. The following is the summary list of these occasions, which is all that can be presented here and now. Particulars can easily be filled in from the *Cambridge Modern History* or other convenient textbooks. (1) The revolt of the Greeks from the Turkish suzerainty, that at one time seemed likely to embroil Russia with Austria on the one side and Britain on the other, was finally settled by Conference at London, and this in spite of the fact that Austria and Prussia refused to send representatives, thus leaving Russia, France, and Britain to find the path of peace. The problem was solved by 1833, when independence was secured, boundaries delineated, and a kingdom under Otto of Bavaria set up. (2) The separation of Belgium from Holland in 1830 gravely threatened a general European war. For not only did William of Orange refuse to recognise the disintegration of his kingdom; he was supported by his brethren of Russia, Austria, and Prussia. The good instances of France and Britain resulted in the settlement of the conflict by diplomatic means, and in 1839 the final partition was peacefully accomplished. (3) In 1840 the Near Eastern question once more disturbed the Christian Powers of the West. Mehemet Ali of Egypt rose in revolt against his sovereign the Turkish Sultan. France, then in search of glory under the guidance of Thiers, lent him encouragement and support. A series of striking military successes gained by Mehemet and his warrior son seemed to portend the dissolution of the Turkish Empire. The four Powers—Russia, Austria, Prussia, Britain—however, by timely and decisive intervention, saved the Sultan from ruin, forced France to withdraw her support from Mehemet and to abandon her neo-Napoleonic policy in the East. Whatever may be said as to the ultimate righteousness and wisdom of the policy of the maintenance of the integrity of the Turkish Empire, there can be no doubt that at the moment the action of the Quadruple Alliance prevented a gigantic upheaval. (4) In 1852 a menacing problem relating to the Danish succession was dealt with and solved amicably in a Conference held at London, and attended by representatives of the five Great Powers, together with those of Norway, Sweden, and Denmark. (5) In 1856 the status of Serbia and Rumania, both of which had secured virtual independence, was treated and decided at Paris by plenipotentiaries from the five Powers, plus Sardinia and Turkey. (6) The very formidable question of the position of Luxemburg, which in 1867 seemed likely to precipitate the Franco-Prussian War, was referred to a Conference of diplomats representative of the five Powers together with Italy (now the sixth Great Power), Holland, and Belgium. The Conference successfully dealt with the thorny problem, and arrived at that treaty settlement of neutrality which regulated the status of Luxemburg as a buffer-duchy down to the outbreak of the war of 1914. (7) In 1884 the Powers, in conference at Berlin, removed Africa from the sphere of probable conflict—into which it had been brought by the sudden outburst of German colonial activity during that year—by carefully partitioning it into zones of influence. (8) In 1900 they did the same for Oceania. (9) In 1906 they obviated a Franco-German struggle respecting Morocco; and, finally, (10) they postponed the Great War for a few months by their London agreement concerning the Balkans in 1912–13. These are achievements of no mean magnitude, and they need to be taken into account and carefully weighed by those who tend to talk too readily about the "European Anarchy" of modern times. There was a good deal more "International Government" in Europe during the nineteenth century than some political critics are disposed to allow. It was, however, it may be freely admitted, of a very imperfect and rudimentary kind. If it was strong and effective enough to prevent wars on ten or more occasions, it failed to do so on at least five others.

V

The wars which the Concert of Europe failed to prevent during the nineteenth century were, first, the Crimean War of 1854; secondly, the War of Italian Liberation, 1859; thirdly, the wars for the unification of Germany and the aggrandisement of Prussia, 1864, 1866, 1870; fourthly, the Russo-Turkish War, 1877; and, finally, the German War for world dominion, 1914. In each case strenuous efforts were made by the Powers not primarily concerned to mediate, to arbitrate, to compose the causes of quarrel by negotiation, to secure the calling of Conferences and Congresses. In each case these efforts failed, and we can now clearly discern why they failed. The issues at stake were too great, and of too vital an importance to one or more of the States involved, to be settled by any of the feeble and ineffective organs which the Concert of Europe had then at its disposal. The deep causes of these unprevented and (in the circumstances) almost inevitable wars were broadly one or other of two; they may be briefly distinguished by the labels "national" and "imperial." The Italian war of 1859 was a national war. It was necessary to expel the Austrians from the peninsula, and in the middle of the nineteenth century there was no means of doing it except by fighting. Such a gigantic task was quite beyond the competence of the then existing Concert of Europe. To prevent in the future such a war as that of Italian liberation a "League of Nations" will have to possess immense legislative and executive powers. Similarly the Prussian wars of 1864–70 were national. The grand issue, foreseen by Bismarck and his associates, was the unification of Germany under the Prussian hegemony. The attempt to effect this end by constitutional and parliamentary means had conspicuously failed in the years 1848–52, and Bismarck had clearly perceived and plainly said that "not by speeches and resolutions of majorities are the mighty problems of the age to be solved, but by blood and iron." The unification of Germany under the Hohenzollerns necessitated on the one hand the extrusion of the Hapsburgs, and on the other the destruction of the hostile empire of Napoleon III. In the existing condition of things nothing but war could accomplish these requisite tasks. So, too, nothing but war could in 1877 secure the emancipation of the Bulgarian nation from the Turkish yoke. National problems like the Italian, the German, and the Bulgarian involved political disintegration and reconstruction of so radical a character as to baffle all the resources of nineteenth-century diplomacy. The Concert of Europe could do much to preserve peace by the maintenance of the *status quo*: it could do little or nothing to preserve peace by the diplomatic facilitation of the transition to the *status ad quem*. So much for the national causes of the great nineteenth-century wars. The other leading cause was imperial ambition—an ambition not limited to an imperial ruler, but shared by an imperial army, and supported and applauded by an imperial people. The Crimean War—one of the most unnecessary and futile conflicts in the world's history—was forced upon a reluctant but bewildered Europe by the insane lust for military glory which possessed Napoleon III, and by the unyielding pride and obstinacy of Nicholas I of Russia. Mediation and persuasion were lost upon autocrats of the temper of these two. Behind them, however, were two nations each of them infected by the belligerent passions that made the foolish struggle unavoidable. Thus, too, was it in 1914. In vain did Sir Edward Grey and his colleagues exhaust the resources of conciliation to prevent the outbreak of the world war. German imperial ambition had deliberately prepared the conflict, and no human power then extant could avail to stop it or postpone it. And behind the German Emperor stood the German army eager for the long-anticipated "fresh and joyous fight," while behind the German army, and confident of its invincible power, stood the German nation waiting to exploit the earth. Against such a formidable imperial "will to war" the Concert of Europe was helpless. If in future a "League of Nations" is to be effective in similar conditions, it will need to be very strong indeed, and very quick in action.

VI

Both the successes and failures of the nineteenth-century Concert of Europe are instructive. Its very considerable successes point the path along which the nations may securely tread towards that goal of perpetual peace which they now so ardently seek to attain. They show that problems of all kinds are amenable to peaceful settlement; that a body of international morality and custom exists which may easily be raised to the rank and efficacy of law; and that a good deal of international machinery has been created which can do much more effectively and much less wastefully the work that has too often been assigned to guns and bombs. The failures of the Concert, on the other hand, indicate that, if all wars in the future are to be obviated, there is need of an international authority strong enough on the one hand to crush all efforts of imperial ambition to extend its own dominion, and on the other hand to handle and solve the insistent problems raised by national consciousness and desire—strong enough to satisfy legitimate national demands even at the cost of the disintegration of old-established states; strong enough to resist and refuse the unreasonable demands of pseudo-nationalities. The Concert of Europe failed in the crucial cases because of its lack of real unity; because of the particularism of its members; because of its want of legislative, executive, and judicial authority. If a "League of Nations" is to succeed where the Concert failed, there must be congruity among its members—i.e., they must all be democratic States which accept the same general principles of representative government; they must bind themselves in a close and permanent alliance in the full consciousness that in doing so they are each of them surrendering into the common stock a large measure of their former independence and sovereignty; and they must maintain not only the necessary legislative, executive, and judicial organs of international government, but also armed forces capable of suppressing disorder and enforcing the general will.

The Origin of the Solar System

By Harold Jeffreys, M.A., D.Sc.

Fellow of St. John's College, Cambridge

How is it that the earth can keep its atmosphere? We know that when a person smokes in one corner of a room it is only a few seconds before the smell is noticeable all over it; and that when a small amount of a gas is let into a chamber from which the air has been exhausted, it expands in a fraction of a second so as to fill it completely. Yet the earth's atmosphere, with a more perfect vacuum outside it than any we can make, manages to persist for thousands and even millions of years. Why does it not spread out and become lost to us? The answer illustrates one of the most important principles in modern theories of the origin of the solar system. If a body is thrown up, it falls down again; but if it was thrown with more than a certain "critical" velocity, about 11 kilometres (7 miles) per second, it would not return to the earth at all; it would travel off into space and revolve round the sun. Now a gas consists of a vast number of small particles, called molecules, rushing about in all directions with different velocities; their average velocity depends on the constitution of the gas and on its temperature, but is in terrestrial conditions always of the order of a kilometre per second. Individual molecules may, however, attain much greater velocities. If, then, a molecule on the outskirts of the atmosphere attains the critical velocity, it passes off into space, but not otherwise. At the present time this rarely happens; our atmosphere is being lost so slowly that it will be billions of years before any change is appreciable.

We know, however, that the earth is very hot inside, and there is very strong geological reason to believe that it is a cooling body, and that a long time ago it was actually liquid at the surface. But that may not have been the start; before that it may have been largely, perhaps wholly, gaseous. In these circumstances it must have been much larger in size than it is now, and this would cause the critical velocity to be less. On the other hand, the high temperature would make the velocities of the molecules of the air greater, and it would on both accounts have taken the air a shorter time to be lost. But our atmosphere may have come since then from the inside of the earth, in the form of volcanic gases, and have been gradually altered in composition by living organisms. We can go further, however. The iron and silica that constitute most of the earth must have been vapour then, and we can show that these must have been lost had the earth had more than three times its present radius; and then there would have been no earth left. In fact, whatever we suppose to have been the origin of the earth, whether solid, liquid, or gaseous, it can never in any circumstances have had a specific gravity of less than $\frac{1}{5}$. The larger planets, on account of their greater masses, could hold together when much more widely distended; but the smaller bodies of the system, such as the asteroids and most of the satellites, would have been dispersed for much smaller distensions. In fact we can show that these can never have been gaseous at all, and must therefore have been solid or liquid ever since they had a separate existence.

The theories of the origin of the planets fall into two classes. In the older theories (those of Laplace, Roche, Faye, and Lockyer, for example) the formation was supposed to be by some process of gradual condensation from a more or less symmetrical gaseous or quasi-gaseous mass surrounding the sun. The above argument shows that these are untenable. The matter near the earth must have had a density of at least $\frac{1}{5}$, otherwise it could never have condensed at all; and as the sizes of Mercury and Venus are still less, we see that the density nearer the sun must have been greater than this. When we calculate what the mass of the matter within the earth's orbit must have been on this basis, we find that it must have been at least a million times what the mass of the sun is now. There is no way in which such a mass of matter can have left the system, and accordingly these hypotheses must be abandoned.

The condensation must therefore have taken place from a very limited region, occupying not more than a millionth of the volume of the solar system. Yet it must have extended from Mercury to Neptune. A mass of this extreme length and thinness could not possibly last more than a few years without breaking up; it must therefore have been suddenly formed, and broken up into the planets soon afterwards. In a long and detailed investigation Jeans has recently shown that such a filament could have been produced in only one way. When the sun was largely gaseous and much distended, a star considerably more massive than itself must have approached. The sun's envelope became egg-shaped, the sharp end pointing towards the star, and when the star came near enough this end became actually pointed. At this stage the tendency to disruption produced by the star just balanced the sun's tendency to hold together on account of the mutual gravitation of its parts. With a slight further approach the point opened into a gap, and out of it poured the gases of the envelope, slowly at first, more rapidly as the star came nearer, and slowly again as it receded in its hyperbolic or parabolic orbit. The filament shot off was therefore thickest in the middle. As the star passed on it attracted the filament towards it, with the result that the whole was given a motion of revolution around the sun in the plane of the motion of the star. This narrow gaseous body could not, however, remain long unaltered. It can be proved that any such body must in time break up into a row of fragments on account of the mutual attraction of its parts. Thus the planets were formed, and on account of the variation in thickness the largest were at the medium distances from the sun. At the same time cooling would take place, partly owing to increased radiation from the extended surface, and partly because it would tend to expand under the low pressure ; for expansion leads to cooling. (To observe the opposite effect due to compression, pump up a bicycle tyre quickly and see how hot the pump gets.) Thus much of the matter in it would soon liquefy. In this way a number of planets of varying sizes would be formed, the largest in the middle, and all moving in one direction, and nearly in one plane ; the largest would be mostly or wholly gaseous, and the smaller ones liquid. The resemblance to the actual solar system is obvious ; for Jupiter and Saturn, the largest planets, are at medium distances from the sun, and appear to be still partly gaseous, and all the planets do move nearly in the same plane. The smaller ones have of course solidified since. Thus the theory that was adopted, because it was the only one that could account for the existence of the smaller bodies of the system, accounts immediately for several other striking features. But its success does not end there.

Not all the ejected matter could collect to form the planets. Much of it quickly spread out through the system before it had time to condense ; this became a very rarefied gaseous mass, filling the whole of the system at least as far out as the orbit of Neptune. It was in motion to start with, and each part of it would continue to revolve round the sun as the planets do.

The primitive planets would move in very eccentric orbits, passing near the sun at one part of their revolution, while their furthest distances would be very great. In moving to and from the sun like this they would experience a great resistance from the gas they were travelling through. Hence this motion would gradually be damped out, and the planets would come to move in nearly circular paths, as they do now. At the same time the medium itself would be altered. It would always be tending to spread into outer space, just like a planet's atmosphere, and would therefore be gradually lost. This would be accelerated by the friction of the planets moving through it, which would keep the temperature high. The matter causing the zodiacal light is probably the last remnant of it. The great planets would, by their gravitation, collect large masses of compressed gas about them ; these would move with them, thus very much increasing the surface that was being pushed through the medium. This surface would in fact be almost proportional to the square of the mass of the planet, and consequently the larger the planet the more would its orbit be altered by friction. This agrees well with the present eccentricities. The four great planets have small eccentricities, and the largest eccentricities are those of the smallest planets, Mercury and Mars. The earth and Venus have even smaller eccentricities than Jupiter, but this is only temporary ; it is known that their eccentricities oscillate within wide limits.

The formation of the satellites is more difficult to trace, not so much on account of any inconsistency with the theory as on account of the variety of methods, all consistent with the theory, that often offer themselves in particular cases. We shall consider these in turn.

When the planets approached the sun very closely at their nearest points (their " perihelia "), the sun must have raised great tides in them, and this may have caused filaments of matter to be shot out in the same way as the approach of the star caused a filament to be shot out of the sun. In the case of the great planets this caused systems of satellites to be formed, each satellite system resembling the solar system as a whole in that the largest satellites would be at the medium distances, all would revolve in the same direction and approximately in the same plane, and the eccentricities of their orbits would gradually come to be small. This is true of the satellite systems of all the outer planets, except that the outermost satellite of Saturn and the two outermost of Jupiter revolve in the opposite direction to the others. Also the direction of the revolution should be the same as that of the revolution of the planets ; but the four satellites of Uranus revolve in a plane at right angles to this, and the one satellite of Neptune revolves in nearly the opposite direction. These are difficulties that await solution.

Some of the satellites, however, may be as old as the planets. If a small nucleus in the original filament happened to be near a large one when it was formed, it might have continued to revolve round it ever since. For this to happen it must have been a long way off, so that it would not get involved in the dense matter that afterwards condensed into the planet. Now, it appears that if a satellite is at a great distance from its primary, it is least disturbed by the sun's attraction if it moves round the primary in the opposite direction to the usual one. Thus when a satellite in a direct orbit would suffer great perturbations, and perhaps be forced ultimately to leave its primary altogether, one of these " retrograde " satellites might survive. This may be the origin of the retrograde satellites of Jupiter and Saturn, which are so much more remote from their primaries than the furthest of the others that there seems to be a fundamental difference between them. Further, as they were not within the compressed gas around the primaries, their eccentricities would not have altered much ; and actually they have very large eccentricities.

The anomalous satellites of Uranus and Neptune are in a different position again, for they are comparatively close to their primaries. There is no quite satisfactory explanation of their remarkable motions. Perhaps for some reason, as yet unknown, Uranus and Neptune acquired abnormal rotations from the start (and the retrograde satellites of Jupiter and Saturn suggest that there was something peculiar about the local motions at the outer end of the original filament), and either by tidal action, or by forcing the medium near them to rotate with them, caused the orbits of their satellites to turn round till the satellites revolved nearly in the equatorial planes of the primaries.

The moon may have been a primitive nucleus like the retrograde satellites of Jupiter and Saturn, but it is not very likely, for several reasons. In the first place, it is certain that the moon has been receding from the earth for ages, and when the oldest known sedimentary rocks were laid down it must have been very much nearer than it is now. This follows from the facts known about tides in shallow seas, and is confirmed by two results of observation. If from the data we have about the moon we calculate its position at some past time, some thousands of years ago, it is found that its observed position then was somewhat further west, and the difference is nearly such as would be expected from the theory of the tides. Again, certain facts about the shape of the moon indicate that it did not become solid when at its present distance, but at about a third of it. It is unlikely that two separate nuclei were formed at such a short distance apart, so that the moon was probably initially part of the earth.

If the primitive earth-nucleus was broken up by tidal action in passing near the sun, the change would not have taken place in the same way as was suggested for the great planets. The earth was much more dense than these, and was probably largely liquid from the start. Now, a liquid or solid body broken up by tidal action would not eject a long filament and form a series of satellites : it would break into two pieces, one large and one small, very much like the earth and the moon. I do not, however, think that the moon was formed in this way. If a body was once broken up like this, there is no reason why it should not happen again and again, forming in succession four, eight, sixteen, and more pieces, until the bits were so small that they cooled and solidified, when their cohesion might afterwards hold them together. The solar system actually seems to contain two examples of this. The rings of Saturn are composed of many tiny bodies, and are generally believed to be the result of the destruction of a satellite in this way. Also the asteroids may have been formed from a primitive small planet, broken up by approach to the sun, or more probably to Jupiter, in view of the large eccentricities of some of their orbits, which could not have survived if they had been very old.

It seems more likely that the moon was formed after the earth's orbit had become much more nearly circular. Consider for a moment a man in a swing. If he is pulled back for a moment and released, he performs a few oscillations and gradually comes to rest. But if we give him a push every time he is nearest to us, the oscillations get bigger every time. This increase in the extent of a vibration when the force from outside has a period equal to the natural period is known as "resonance." Now, if the liquid earth was distorted so that its equator became an ellipse, it would oscillate backwards and forwards about the circular form till it came to rest, and the period of this motion would be about two hours. But we can show that, if ever the earth and moon formed a single body, this must have rotated in about four hours, and hence the solar tide at any place on it would give the requisite push or pull every two hours. The oscillation would therefore grow, and it is likely that it became so huge that the mass broke into two pieces.

The satellites of Mars offer a difficulty on account of the smallness of their primary. For Mars must have been almost wholly liquid at the start; and if it was broken up by tidal action, it should have produced satellites comparable in mass with itself, whereas they are actually only a few miles in diameter. They may be asteroids that have been attracted out of their original paths and caused to revolve round Mars.

The only other bodies unaccounted for by the theory are comets and meteors. These are almost certainly of more recent origin, and took no part in the birth of the system.

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New Light on Old Authors

II. Vergil among the Prophets

By R. S. Conway, Litt.D., F.B.A.

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It is one of the most interesting facts in the literary, and indeed in the religious, history of Europe that the Roman poet Vergil, who died in 19 B.C., should have been counted for some eighteen centuries an inspired prophet of the Christian Messiah. Nor was the belief merely a popular tradition cherished by those to whom Vergil was only an ancient name, like the belief in his magical powers which survives among the Italian peasantry to this day. It was precisely the most noble and learned students of Vergil's own writings who held the belief most strongly.

The Emperor Constantine recognised Christianity as the religion of the Roman Empire in A.D. 313; and according to his biographer, the Bishop Eusebius, one of the ways in which he justified his action was by appealing to Vergil, the most revered of all the poets of pagan Rome. For, according to Constantine and his religious advisers, Vergil had actually predicted the birth and spiritual reign of Christ Himself, though the poet did not name the Deliverer of the world "for fear of persecution," as Eusebius rather quaintly adds. About a century later St. Augustine, the great Bishop of Hippo in North Africa, who was a devoted admirer and student of Vergil's *Æneid*, still maintained[1] that Vergil himself had embodied in one of his poems a real and older prophecy of Christ; though Augustine did not suppose that Vergil himself fully understood who it was whose coming he thus foretold. The belief remained in Italy all through the Middle Ages. As we all know, Vergil was chosen by the greatest of mediæval poets, Dante, as the spirit in the After-world who might most fitly conduct him through the great exploration of Hell and Purgatory, which is the theme of the first two-thirds of his *Divine Comedy*. Nor is this merely the homage of one great poet to another of kindred spirit. Dante expressly tells us many times that Vergil had the power of converting men to a knowledge of Christian truth. And even though Vergil must relinquish the duty of guiding him at the gates of Paradise, Beatrice, the angel who is to conduct him in this last part of his journey, declares boldly[2] that she "will often speak the praise" of Vergil before her Divine Master. More explicitly still, when Dante meets[3] the poet Statius, whom he supposed to have been a Christian, in Purgatory, Statius is represented as declaring that he owed to Vergil's prophecy his first interest and belief in Christianity. In our own country, no farther back than the year 1709, the poet Pope, in his pastoral poem called "The Messiah," accepts the view of St. Augustine that Vergil had taken over the prediction of an unnamed Deliverer from an earlier prophet called the Sibyl.

Pope was a Roman Catholic and followed the tradition of his Church; but his Protestant critic, Samuel Johnson, that pillar of English common-sense and sound literary judgment, does not in the least demur.[4]

On the other hand, modern commentators on Vergil either pass by the whole matter in silence as a thing beneath their notice, or roundly condemn it as a "ridiculous" or "blasphemous" notion. So we have a responsible scholar of the nineteenth century accusing the poet Dante, and the critic Samuel Johnson, of blasphemy! In these painful circumstances it may interest the readers of DISCOVERY to examine the causes which led the great thinkers and poets whom we have named to interpret Vergil so confidently in this way.

The question is really twofold. First, what was there in Vergil to make his Christian admirers and students think him worthy to be a prophet of the Founder of their own faith; and, secondly, what was the nature of the actual poem in which they thought he had made the prediction?

The first question is altogether too large to be answered here.[5] Suffice it to say that no one has read properly even a single Book of that poet if he has not realised something of the profound and tender-hearted personality which made so many great Christians eager to reckon him as a forerunner of their Master. It is the second question which concerns us here, and to which the study of recent years has made it possible to give at least a somewhat fuller answer than ever before.

In an earlier paper, "The Secret of Philæ,"[6] some reference was made to the earliest period of Vergil's poetical work, in which he was closely associated with his fellow-poet Gallus. Like all young poets, they began by imitating their predecessors; and the models to whom it was the fashion to look in Vergil's early days were the later Greek poets who flourished in the third century B.C. at Alexandria, under the patronage of the Græco-Egyptian monarchs who had succeeded to that part of the Empire of Alexander the Great. In that city was the greatest library of the ancient world; and under despotic patrons, originality or breadth of view, or even any great depth of imaginative feeling, might always lead a poet into danger. But it was always safe to study the work of your predecessors and refine upon their style. So it came about that the poets of the Alexandrian Court specialised in what we may call the graceful or picturesque style of poetry, concerning themselves with comparatively humble or merely sentimental themes. Most of them made it their business to decorate these with a wealth of learning. In particular, they developed the artificial type of poem which we call the Pastoral. Some of the Alexandrian Pastorals, for example several of those by Theocritus, really are what the name implies—pictures of shepherd-life; but most of them were only dialogues of fashionable or literary society prettily veiled by being put into the mouth of shepherds and their comely companions. It was this type of poem to which Vergil first turned when he began to write work of his own. But there is one of the ten Eclogues, as his Pastorals are called, which has somehow transcended the narrowness of the frame in which it is set.

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[1] *Ep. ad Rom. inchoata expositio*, i, c. 3.

[2] *Inferno*, ii. 73.

[3] *Purgatorio*, xxii. 61.

[4] Johnson, *Lives of the Poets*, edited by M. Arnold, p. 419.

[5] Further details of the reasons which naturally inclined the Christian Church in the early centuries to regard Vergil as prophesying a Messiah, especially his sense of the guilt of mankind, his confident hope of a Heaven-sent Deliverer, and the kind of spirit which he expected the Deliverer to introduce, have been described in the Essay on *The Messianic Idea in Vergil*, to which reference is made at the end of this article.

[6] DISCOVERY, vol. i, p. 4.

The Fourth Eclogue is full of imitations of older poets, and marked also by much of the pretty fancy associated with a not wholly serious kind of poetry. But it is so original and so complete in itself and so very much in earnest, that it has always been read for its own sake, and even criticised for some of the features which really belong to its framework; that is to say, features which were indispensable if it was to rank in any sense as a Pastoral of the current type, such as the general atmosphere of mythology produced by frequent allusions to old-world stories.

The poem itself tells us when it was written, namely in the year 40 B.C., when Pollio, to whom it is dedicated, was Consul. Pollio was a friend both of Octavian, then just twenty-three years old, and of Vergil himself; and in that year he had rendered great service to Octavian, and indeed to the world, by bringing the turbulent Mark Antony to the agreement with Octavian that is commonly known as the Peace of Brundisium. By this the two practically agreed to divide the Empire between them: Antony was to have the East and Octavian the West. The conspirators who had slain Julius Cæsar had been overcome two years before, and something like the end of the Civil Wars seemed to be in sight for the first time for ten years; the epoch of revolution, in which war of some kind, often civil war, had never ceased, had lasted for nearly a century. The poem celebrates the prospect of this great deliverance, a deliverance which affected not Rome merely, but the whole of civilised humanity. But the poet's hope is linked to one particular event to which he looks forward as a typical part of the new order of things—namely, the birth of some young Prince who is to rule a regenerate world.

The main part of the poem begins by referring to some prophecy attributed to the Greek Sibyl of Cumæ, the legendary figure whom in the *Æneid*, later on, Vergil represented as having introduced Æneas to the Under-world, and whom popular folklore represented as having sold a fraction of her prophecies to King Tarquin for the same sum as she had asked at first for the whole. Vergil's reference was probably not to the official "Sibylline Books," as they were called, which were consulted from time to time by direction of the Senate, but to some more accessible collections of Greek prophecies of the same kind. In them must have been embodied the favourite doctrine of ancient, especially Etruscan, astronomers that at a certain point all the heavenly bodies would be in the position in which they stood at the beginning of the world; and that consequently all human affairs, being, as was supposed, governed by these celestial movements, would repeat themselves over again.

The first of all the ages of Mankind had been, in popular belief, an age of gold under the rule of Saturn. During it gods had walked with men on earth, and the last of the gods to leave the earth because of its increasing wickedness had been the Maiden Justice.

Now it is time to let Vergil speak for himself, at least so far as a rough rendering[1] will allow:

> Lo, the last age of Cumæ's seer has come!
> Again the great millennial æon dawns.
> Once more the hallowed Maid appears, once more
> Kind Saturn reigns, and from high heaven descends
> The firstborn child of promise. Do but thou,
> Pure Goddess, by whose grace on infant eyes
> Daylight first breaks, smile softly on this babe;
> The age of iron in his time shall cease,
> And golden generations fill the world.

From this prayer to Lucina, the Goddess of Childbirth, the poet turns to Pollio, whom he congratulates on the great beginning that is to take place during his Consulship:

> Under thy banner all the stains of ill,
> That shame us yet, shall melt away and break
> The long, long night of universal dread.
> For the child's birthright is the life of gods;
> Heroes and gods together he shall know,
> And rule a world his sire has blessed with peace.
>   For thee, fair child, the lavish earth shall spread
> Thy earliest playthings, trailing ivy-wreaths
> And foxgloves red and cups of water-lilies,
> And wild acanthus leaves with sunshine stored.
> The goats shall come uncalled, weighed down with milk,
> Nor lion's roar affright the labouring kine.
> Thy very cradle, blossoming for joy,
> Shall with soft buds caress thy baby face;
> The treacherous snake and deadly herb shall die,
> And Syrian spikenard blow on every bank.

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[1] Two other renderings, one in the original metre and one in Biblical prose, both very interesting, are given by Mr. Royds in the book mentioned below.

After this picture of the fairyland which is to surround the infant's cradle, the poem traces the growth of the child to manhood, and the gradual improvement in the world's condition which will keep pace with it; and the prophecy concludes with a kind of magic incantation drawn from more than one philosopher's dream:

> "Run, run, ye spindles! On to this fulfilment
> Speed the world's fortune, draw the living thread."
> So heaven's unshaken ordinance declaring
> The Sister Fates enthroned together sang.
> Come then, dear child of gods, Jove's mighty heir,
> Begin thy high career; the hour is sounding.
> See how it shakes the vaulted firmament,
> Earth and the spreading seas and depth of sky!
> See, in the dawning of a new creation
> The heart of all things living throbs with joy!

Then, after claiming the privilege of celebrating the Prince's later achievements, the poet turns back to the cradle, still waiting for the infant, and prays for a happy birth. The prayer is worded in old-time fashion, bidding the child smile at once upon its mother—accounted the best of good omens—and comparing him to Hercules, most favoured of mortals, who lived to wed Hebe, the Goddess of Perpetual Youth, and to receive the gift of immortality from Jove himself.

> Come, child, and greet thy mother with a smile!
> Ten weary waiting months her love has known.
> Come, little child! Whoso is born in sorrow
> Jove ne'er hath bidden join the immortal banquet,
> Nor deathless Hebe deigned to be his bride.

But now, who was the child whose birth was thus confidently anticipated? That is the puzzle.

In the first place I assume without discussion, as something obvious to every reasonable reader of the lines which have just been rendered, that it was a real child of flesh and blood whose advent the poem was to herald. There have been scholars who have read even the line about the waiting mother in such a way as to interpret the child as a mere allegorical figure, meaning a new world. But after all, as Dr. Warde Fowler observes, one requisite for understanding poetry is a sense of humour; and this seems a little wanting in such interpretations.[1]

Now, it will be easy for the reader himself to observe in the passages that have just been rendered some of the likenesses to Old Testament prophecy, especially that of Isaiah.[2] Nor will he be altogether surprised, though he may well be amused, to find that Constantine and Eusebius interpreted the "Maid" (*Virgo*) of the opening lines as a prediction like that of the birth of Emmanuel.[3] And it is even likely that he will be persuaded if, with recent writers, he studies the matter more fully, that Vergil himself had some direct or indirect acquaintance with the thought and imagery of Isaiah. These are literary questions of interest; but they leave the central point of our curiosity still to be satisfied. Grant that the young poet's vision of a world-wide peace to succeed a century of misgovernment and oppression was dressed in colours like those in which Jewish poets and prophets had depicted theirs. Grant that this great hope kindled within him an enthusiasm so deep and wide that it seemed to wrap the whole world in its light. Grant even that a poet naturally associates a great vision of deliverance with the person of some deliverer. Even if all this be assumed, we still ask, Why was the deliverer to be identified with an infant not yet born, and who was the infant?

On these questions the ancient commentators, who generally tell us most about Vergil, give us some evidence, valuable indeed, but negative. It amounts to no more than that a certain person told somebody else that he, the speaker, was the infant whom Vergil expected to be the world's deliverer. The person in question lived and died and did nothing in particular; but the story shows that the authority that quotes it was himself in the dark, though convinced that the claim of this particular person was absurd.

A further question then arises: What was Vergil's motive in setting his readers such a riddle? Surely even the extracts that have roughly been translated will show that the poet was very much in earnest, not writing a playful sketch of some wholly baseless vision?

Three or four different modern scholars in England, Germany, and America have independently arrived at the same conclusion, guided by the obvious reflection that the child who was to do so much for the world must have been the offspring of someone in whose hands the destiny of the world then rested. As we have seen, Octavian and Antony had just agreed to divide the Roman Empire between them. As between these two names, even in 40 B.C., when Octavian was only at the beginning of his great work, there can be no real hesitation. Could any peace or salvation for humanity be expected from the ruffian[4] Mark Antony, the lover of Cleopatra, even if he had been persuaded to abandon her (for a time) for Octavia's hand? No, if the child was to be a deliverer, the only father that we can attribute to it must be Octavian himself. Further, we know that Octavian's wife, Scribonia, was hoping for a child to be born to her at the end of this very year. Who was this child? It was the Princess Julia, born in January 39 B.C. We know that the sex of the child was a bitter disappointment to Octavian, a disappointment which increased all through his life when no male heir was ever born to him. Is it unreasonable to see in this disappointment the reason for the poet's silence? After all, the poem was published; after all, it concerned the work of the child's father more than the child itself; it concerned the great hopes of the world more than either; and Vergil might well feel in later life, as indeed everyone felt after the wonderful advent of universal peace nine years later, that the hopes had begun to be fulfilled.

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[1] The objection that it was unseemly for a poet to prophesy such an event is a natural one from the point of view of modern English taste; but that the ancient feeling was quite different can be easily shown. See *The Messianic Idea in Vergil*, pp. 30 and 84. There is a poem of Martial in honour of an expected child (of the Emperor Domitian) which was never born at all.

[2] Chapters ix, xi, and xliv.

[3] Isaiah vii. 14.

[4] This view has indeed been maintained, apparently in complete forgetfulness of the facts depicted, e.g., in Cicero's *Philippics* (44–3 B.C.).

[This paper is based on a volume in which the writer had some part, entitled *Vergil's Messianic Eclogue* (John Murray, 1907). Since then the question has been further studied, especially from the point of view of ancient prophecy, by the Rev. T. F. Royds in the volume entitled *Vergil and Isaiah* (Blackwell, Oxford, 1918); and in these two volumes full references will be found to earlier authorities.]

Metal Discoveries of Antiquity and To-day

By Edward Cahen, A.R.C.Sc., F.I.C.

GOLD, as might have been expected from the fact that it occurs native, was the first of all the metals to be discovered by Neolithic man; and even to-day this metal still exerts a greater power for good and evil than any other, though there are now plenty of metals which are more rare and more costly. From our early ancestor's point of view gold possessed the great advantage that it required no smelting, there was no need to find out how to get it from its ores; there the metal was ready for use, glistening in its pristine splendour, and so soft that it could easily be fashioned into ornaments; too soft, it is true, to be of any service for weapons. He therefore had to look round and see if he could not find something a little harder which would serve for this purpose, and it was not long before he came across another native element, copper, from which he fashioned implements of the same shape and design as his stone ones. From copper to bronze is but a little step, and one that may possibly have been taken by accident, as is suggested by Gowland. Its discovery may have been a matter of chance: a little copper ore, with which some tin is nearly always associated, may have got into the stones which served early man for fireplace. The charcoal would smelt the ore, reducing the metals and making an alloy which would be found among the ashes, and seized upon with joy by primitive man as just the thing from which to make fine weapons on account of its superior hardness. Iron was at first a great rarity, and may possibly have been of meteoric origin, and used for ornamental purposes only. Later the Hittites seem to have found out how to smelt it from its ores, and Wells, in his *Outline of History*, records how one of their kings "promises iron as a most precious gift," quoting from a collection of letters found at Tel-el-Amarna. In early Egyptian times silver was also known, but it was esteemed nearly as highly as gold.

From the above very brief sketch it will be seen how very few metals were known in the very early days of recorded events which we call history; since then no fewer than sixty-one metals have been discovered, though even now by far the greater number of them remain as unknown to the great mass of the people as if they had never been found. Yet we shall see how many of the amenities of modern life in great cities are due to the discovery first of all of these metals themselves, and secondly of the use to which they could be put. In this article some account will be given of what are often known as the rarer metals, to distinguish them from those in everyday use such as gold, silver, copper, and iron; the name does not, however, necessarily imply that the metal is rare in the sense that but little of it is known to exist, for many of the rarer metals occur in very considerable quantities—titanium for instance, which is so largely employed in the steel industry, and also for colouring practically all the artificial teeth.

What usually happens is that a new metal is discovered at first in very small quantities, some peculiar properties it may possess mark it out for some particular use, search is made for more of the metal and more is generally found. In this way the supply keeps pace with the demand. At other times large quantities of one of the rarer metals may be associated with very small quantities of another for which a use has been found; a large and accumulating surplus of the other is thus created, and the problem arises what is to be done with this waste-product, a problem which has to be solved by some new discovery.

The gas-mantle industry furnishes us with by far the best example of both these cases, and particularly the latter. It was discovered that the oxide of a rare metal, thorium, which was found in certain rare minerals from Norway, glowed with a very powerful light when rendered incandescent with heat. Search was therefore made to discover other minerals in which this rare metal occurred in quantities plentiful enough to start an industry. The Germans were not long before they discovered a sand on the sea-shore of Brazil which answered the purpose exactly. This was monazite, which consists chiefly of a phosphate of a rare metal, cerium; but it also contained about 6 per cent. of the thorium, the metal of which they were in need. The story of how the Germans succeeded in getting the monopoly of the monazite of practically the whole world is a very interesting one, but we have not the space to tell it here; suffice to say that the outbreak of war in 1914 put an end to this state of things, and secured for Great Britain the use of her own supplies from Southern India and Ceylon. The thorium was extracted from the sand, and Auer von Welsbach, after numberless experiments, found out how to make the gas-mantles which are so common a feature of every home. These mantles consist of 99 per cent. thorium oxide and only 1 per cent. cerium oxide, these proportions yielding the brightest light. The problem therefore arose how to use up the waste cerium and the other rare elements, such as didymium, associated with it. A use was found for a very small quantity of didymium for printing the trade mark on the mantles, the oxide of this metal showing up pink on the white background of the mantle. But this small quantity had in no way solved the problem, when Welsbach noticed that, if all these metals were reduced together to the metallic state, he obtained a mix metal which when struck against steel emitted bright sparks; in this discovery we have the origin of the countless pyrophoric alloys which can be bought to-day either as cigarette-lighters or as contrivances with which to light the kitchen gas-ring. These mix metals or pyrophoric alloys are now being manufactured in huge quantities at a quite reasonable figure in America and elsewhere.

The rare metals have, however, served in another way to make life brighter for us: of the countless electric bulbs which illumine our dwelling-houses and offices, practically all are now composed of metal filaments (hence their name "metal filament lamps" or "drawn wire lamps") which, when rendered incandescent with the current, glow with a bright light in their little glass globes from which the air has been extracted. In the earliest of these lamps the filament was made of carbon, and the connection with the current was by means of thin platinum wires. These early efforts were very feeble when compared with the metal filament lamps of to-day. The metal now employed in their construction is for the most part tungsten, though this is by no means exclusively the case. This metal, although it is by our definition a rarer metal, occurs in very large quantities throughout the world as the mineral wolfram, which is found among other places in our own Cornish tin-mines, where it was a source of endless trouble to the early miners, who threw it out on the dumps, not knowing what to do with it. Since these early days tungsten has become more valuable than the tin itself, not only on account of its use in the electric bulb industry, but also for the peculiar properties it confers upon steel, when it is alloyed with the latter, and it has given rise to what is tantamount to a revolution in this industry. Although tungsten was by no means the first metal to be used in the steel industry for this purpose, and is certainly not the only metal in use to-day, it is perhaps of greater importance than any other. On tungsten depends the resistance of armour plate to enemy attack, and it is also invaluable in the production of high speed tools, which do not lose their temper even at a red heat. Tungsten has on these two counts been called the key-metal of this war by Colin G. Finck, who in a clever little article has shown that the nation which could command the supplies of tungsten was bound to gain the mastery, as the Neolithic man armed with bronze was certain to overcome his predecessor armed alone with stone, and be overcome in turn by his successor with arms or iron; and so on throughout the ages, every victor in turn gaining the mastery over his opponent by the ascendancy conferred on him by some key-metal. It seems hardly credible, under the circumstances, that when the war broke out we were absolutely dependent on Germany for our supplies of tungsten, though the ores were actually exported from these shores only to be returned to us as metal. This state of things was very soon altered by the erection of a Government tungsten factory at Widnes in Lancashire, and Great Britain was rendered self-supporting in this all-important metal.

Most of the metals used for endowing steel with special properties are prepared in the form of iron alloys; among these may be mentioned ferro-manganese, ferro-tungsten, ferro-chrome, and ferro-vanadium. As a rule they are prepared by one of two methods, the thermit process or the electrical furnace, in both of which high temperatures are reached. The use made of the rare metals is surprising to anyone not conversant with this matter. To take but one example: vanadium is a rare metal, which some thirty years ago was worth £90 per pound and was little more than a chemical curiosity; in ten years the price fell to £3, and to-day a ferro-vanadium containing 30–35 per cent. vanadium can be bought for 30s. the pound and considered dear at the price. The reason for this changed state of affairs is the huge demand created by the wonderful vanadium steels, which are imbued with a perfectly miraculous elasticity.

To supply this demand for vanadium, an entirely new source was discovered in the carnotite beds on the borders of Utah and Colorado. This mineral is little more than an impregnated sandstone; and though it is excavated in enormous quantities primarily for the vanadium it contains, it gives rise to a waste-product more valuable than the vanadium itself. This is uranium, another rare metal, which in its turn yields yet another rarer than itself, the famous radium, which caused such a sensation a few years ago, when Madame Curie succeeded in isolating it from many tons of pitch-blende. It remains to-day the most costly of all the rare metals, though in this respect the metal platinum needs some beating, being worth more than £40 per ounce to-day, whereas a century ago an ounce could be bought for a few shillings. The reason for this enormous rise in its price is due to the actual rarity of the metal and the manifold uses to which it can be put. The family to which this metal belongs is a very select one comprising but six members. Of these metallic aristocrats the best known are palladium and iridium; the latter being familiar to most users of fountain-pens, for it is from this metal that the points of the gold nibs are made, together with another member of the same family, osmium, which is alloyed with it. Palladium has received a good deal of attention during the war as a possible substitute for the prohibited platinum, the stores of which had to be reserved for a multitude of national needs, where it was not possible to use another metal. Palladium has been used with some success in the jeweller's art, though it does not possess the unique properties of the nobler metal. The Platinotype Co. have, however, produced a palladio paper which is in every way the equal of, if not superior to, the well-known platinotype papers.

This search for a substitute for platinum has led to the development of another rare metal, tantalum, which has been used with great success for making dental instruments, being very hard, easily sterilised, and not subject to rust. In tantalum we have a metal of which there is plenty to be had, and for which as yet but little use has been found. We have already seen how the Germans, in their search for a cheap source of thorium, discovered monazite in Brazil. This country is the home of yet another rare metal which has had quite a vogue during the last few years. This is zirconium, which occurs in huge quantities in the mineral brazilite, which is almost pure zirconium oxide, from which it is not difficult to obtain the pure material. This is sold under the proprietary name Zircite. It is now being used in ever-increasing quantities as a refractory substance for the manufacture of crucibles, furnaces, and other articles which are required to withstand the high temperatures which are now so easily attained with modern electrical contrivances. Another rather interesting use to which the oxide of this metal has recently been put, chiefly in America, is as a cheap substitute for the expensive bismuth carbonate used in medicine for making X-ray photographs. Zirconium, moreover, finds many other uses in the steel industry and in the drawn filament electric lamps. Combined with yttrium, yet another rare metal, belonging to the family of the rare earths, it is used in the manufacture of the Nernst lamps, formerly much in evidence in physical laboratories. It also finds a special use in the Bleriot automobile head-lights. Zirconium is typical of a case where, given the material, uses will quickly be found for it should it possess particular properties.

There are two or three rare metals for which as yet no use has been found, either because they possess no very distinctive property, or perhaps because they really only exist in very small quantities: who can say? Time alone will answer this question. Of these germanium, gallium, and indium may be mentioned here; and they are interesting from another point of view as being illustrative of the way in which a new metal is discovered. This may happen in several ways; more often than not the chemist stumbles across a new metal when least expecting it, or he may set out more or less deliberately in search of one the existence of which has been predicted. Gallium and germanium are instances of the latter course; they were both predicted by the Russian chemist Mendeléeff by means of his great discovery the "Periodic Law." It was in 1875 that Lecoq de Boisbaudran discovered gallium in a blende from the Pyrenees, after an extensive spectroscopic examination of many minerals. Germanium came to light ten years later, when Winkler was making an analysis of a new silver mineral and found there was a uniform shortage of 7 per cent. in his analysis, which led him to suspect the presence of some unknown metal.

Indium, on the other hand, is an example of the accidental method. In 1861 Reich and Richter were examining two Freiberg blendes for the rare metal thallium, discovered by Sir William Crookes two years earlier; they failed to detect it by means of the spectroscope, but were rewarded by discerning the lines of an unknown metal which they named indium. Thallium is an example of a very rare element having found a use, owing to a peculiar property possessed by it alone, namely the brilliance and high refractive power it imparts to glass, making it particularly suitable for optical work. A source of supply sufficient for this purpose was found in the flue-dust of those pyrites burners where ore containing thallium was burnt.

It may be said that it is absurd to try and give some idea of the importance of the discovery of the rarer metals in so short an article, when each metal is almost capable of yielding a little romance of itself; but in a magazine for general readers it is hardly the business of a writer to dive too deeply into his subject, but rather to suggest the vastness of the subject with which he is dealing. Of the magnitude of the importance of these rarer metals in our modern life there can be but little doubt, and this is reflected in the enormous number of books which have appeared on the subject in one or other of its branches in practically all languages. The four books mentioned below will give the reader a fuller insight into the various branches of the rarer-metal industry.

Monographs on Inorganic and Physical Chemistry. *The Metals of the Rare Earths*, by J. F. Spencer. (Longmans, Green & Co., 1919, 12*s*. 6*d*.)

Manuals of Chemical Technology. *The Rare Earth Industry*, by Sidney J. Johnstone. (Crosby, Lockwood & Son, 1915, 9*s*.)

The Mineralogy of the Rarer Metals, by Edward Cahen and W. O. Wootton. (Charles Griffin & Co., 1920. Second edition just published, 10*s*. 6*d*.)

Die Darstellung der Seltenen Erden, by C. Richard Bohm. (Leipzig, 2 vols., £2 2*s*. 0*d*.)

Outstanding Economic Problems

By Douglas Knoop, M.A.

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So far as this country is concerned, there appears to most people to be one outstanding economic problem at the present time—the problem of high prices. Really the problem is something much wider: it is like a jewel with many facets. The particular facet which we most commonly observe reveals high prices to us. Another facet, however, shows us scarcity. This, for example, is the way the housing problem presents itself to us; it is not so much a question of high rents, but of shortage of housing accommodation which impresses itself upon us. The aspect of scarcity is also felt, though to a less marked degree, in connection with butter and sugar, and with motor-cars and motor-cycles. Scarcity and high prices are always associated together; the competition of would-be buyers seeking to obtain the limited supplies drives up the prices. But with the principal exception of housing, public attention here is much more concentrated on the high prices than on the scarcity aspect of the problem. This is perhaps partly because effects are more easily seen than causes, but partly because the high prices appear to be out of all proportion to the scarcity. This leads us to examine some other facets of our jewel. One facet reveals that a special reason for high prices can be found in the existence of too much paper money, or currency inflation, as it is commonly called. Another facet shows us the closely related phenomenon of the Government relying too largely on advances from banks, and other forms of temporary borrowing, instead of financing itself by means of tax revenue and long-dated loans subscribed for out of the savings of the citizens. Excessive temporary loans, like excessive issues of paper currency, tend to raise prices. Still another facet reminds us of the fact that, when we try to buy foreign currency in order to pay for goods purchased abroad, our pound in many cases no longer has its old power in exchange. This is particularly detrimental to us in the case of purchases made in the United States—our chief source of supply—where our (paper) pound is worth only about $3\frac{3}{4}$ dollars instead of the normal $4\frac{13}{15}$ dollars. Canada and India are two other important sources of supply where our pound no longer purchases as many dollars or rupees as was the case before the war. Let us take an example to show how the unfavourable foreign exchanges help to raise prices here. Before the war, an American product selling for 5 dollars would have cost us approximately 20*s*. 6*d*. Suppose the price in the United States has now doubled. Had the exchange remained normal, we should have been able to purchase the article for 41*s*.—but actually we shall have to pay something like 55*s*. 6*d*.

There are still two more facets of the jewel to which attention may be drawn. One shows us transport difficulties: scarcity of shipping, accentuated by congestion at the ports, which prevents us from getting the best use out of such shipping as is available; and congestion on the railways, which, like scarcity of shipping, prevents goods from being delivered when and where they are wanted. Thus scarcity of goods and high prices are aggravated. The other facet discloses the artificial barriers to trade—such as embargoes and licences. These obstacles to trade have similar effects to defective transport facilities—that is, they increase scarcity and tend to raise prices.

Readers may urge that I have omitted to contemplate one important facet of the jewel, which would portray "profiteering." I have done so deliberately, because "profiteering" is *not* a cause of high prices; it is an effect of high prices, which are caused primarily by scarcity and excessive spending, and in a lesser degree by currency inflation, by unsound loan and taxation policy on the part of the

Government, by unfavourable foreign exchanges (themselves largely due to inflation), by transport difficulties and by artificial trade barriers. If these troubles can be overcome, high prices and the consequent tendency for profiteering will be eliminated simultaneously.

Before discussing, however, the possible cures for our present economic troubles, I want to widen the survey to embrace a brief review of Continental conditions. I do so, partly because many of the countries on the Continent of Europe are faced with the same economic problems as ourselves, but in a much more extreme form, and partly because we are essentially an industrial and commercial country, dependent for many of the comforts and necessaries of life upon our foreign trade. Consequently, if the bulk of our customers and of our sources of supply on the Continent of Europe are at present suffering from more or less acute economic disorganisation, it cannot but have a prejudicial effect on our own welfare.

Mr. J. M. Keynes, in his recent book, *The Economic Consequences of the Peace*,[1] has given us a vivid picture of economic conditions and prospects in some of the principal countries of Continental Europe. As the title of the book suggests, he emphasises the economic problems resulting from the terms of the peace, rather than the problems which may be attributed directly to the war, though it is not always easy to distinguish the two sets of problems. If the facet of the jewel which strikes us most forcibly in this country is that which shows high prices, the facet revealing scarcity attracts considerably more attention in France, Italy, and Belgium, whereas in Germany and Austria it is the dominant consideration. Prices are in many cases appallingly high in these countries, but scarcity, to the point almost of the complete absence of many of the comforts and even necessaries of life, is the aspect of the problem which impresses itself most forcibly upon the inhabitants. More or less extreme scarcity, combined with a flood of paper money, compared with which our over-issues of currency notes appear quite modest, would alone easily account for the tremendously high prices which prevail; but the other contributory causes mentioned above in connection with our own problem of high prices are also present on the Continent in aggravated forms—unsound public finance, unfavourable foreign exchanges, transport difficulties and artificial trade barriers.

The existence of all these phenomena on the Continent can be regarded to a considerable extent as direct or indirect results of the war, even as they are in this country.

The devastation of large areas and the destruction of mines, works, and farms, together with the lack of manures and artificial feeding-stuffs, accounts for some of the special scarcity on the Continent. Further, the disorganisation and congestion on the Continental railways, together with the wearing out of their rolling stock and running tracks, is much more serious than with us. But undoubtedly part of the acuteness of the economic ills from which so much of the Continent is suffering may be attributed to certain terms contained in the Peace Treaty. For a detailed examination of the question I must refer the reader to Mr. Keynes's book. Here I can only touch on the matter quite briefly. The dominant motives underlying the peace negotiations, if we accept Mr. Keynes's analysis of the Versailles Conference, were political and territorial rather than economic. Some readers may, and others may not, accept this view, but in any case there seems little or no doubt that certain of the provisions of the Treaty, whether they were inserted for economic or for other reasons, are almost bound to have a prejudicial effect on the economic recovery of Europe after its five years of war and destruction. Attention may be drawn to just a few points. Under the heading of reparation, an immense indemnity of uncertain amount is to be paid by Germany. In the first place, the uncertainty of the amount Germany is called upon to pay cannot fail to have a bad effect upon the productiveness of German industry, as the Germans, realising that any surplus produced is to be handed over to the Reparation Commission, are not likely to produce any surplus. In the second place, the possibility of receiving large sums by way of reparation encourages the Continental Finance Ministers to continue the unsound financial policy adopted during the war, of placing far too much reliance on loans and on over-issues of paper money. In the third place, if the great indemnity were to be paid, it could only be achieved by Germany developing an enormous export trade, either with the Entente Powers or with neutral countries, which would hardly be in the interests of our export industries.

As a matter of fact, this last contingency seems hardly likely to arise, because the same Treaty, which contains terms about a great indemnity, contains other terms which make the payment of such an indemnity almost impossible. It is hardly feasible both to kill the goose which lays the golden eggs and to receive a regular supply of the golden eggs. Yet that is apparently what the Treaty attempts to do, because in addition to imposing the indemnity, it aims at very seriously restricting, if not actually destroying, the economic life of Germany. The loss of an important part of its coal and iron ore deposits on the one hand, and of the bulk of its mercantile marine and overseas investments on the other, must severely handicap a country which before the war was primarily an industrial and commercial country. Whilst a great expansion of German industrial and commercial activity might prejudice certain of our industries, the economic ruin of Germany would probably prove equally or even more prejudicial to our economic interests. Commerce is to the mutual advantage of the different parties that participate in it ; just as a big business firm does not wish to see its customers go bankrupt and its sources of supply dry up, so this country, which is above all things a trading country, stands to gain much more by developing its Continental trade than by restricting it.

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[1] Published by Macmillan & Co., 8*s*. 6*d*. net.

Where are we to find the remedies for the economic ills from which we are suffering ? Undoubtedly, by seeking to remove the causes which are leading to the high prices. Some system of Government control may possibly check high prices and profiteering ; but it will certainly tend to aggravate scarcity, and thus accentuate the most fundamental cause of all our present economic woes. A much better answer, or series of answers, to the question is supplied by the Supreme Council of the Peace Conference, in their recent declaration on the economic conditions of the world (see daily papers, March 10). It is noteworthy that the recommendations contained in this memorandum are much more likely to rehabilitate Europe than any provisions contained in the Treaty. Scarcity, in conjunction with keen competition on the part of Governments and the general public to secure the limited supplies available, is the prime cause of the high prices. The Supreme Council consequently recommend reduction in expenditure by Governments and individuals on the one hand, and efforts to increase production on the other. With these recommendations every economist will be in agreement. To facilitate the increase in production, the Supreme Council recommend the granting of commercial credits to impoverished countries to enable them to provision themselves with raw materials, and they make a somewhat similar recommendation with regard to help to Germany. One other point on which the Council lay stress is the necessity for an early deflation of credit and currency : payment of current expenses out of current revenue, the cessation of borrowing, the substitution of long-dated for short-dated and temporary loans, and the immediate limitation and gradual curtailment of the note circulation. These steps, if carried out, besides tending directly to lower prices, should render the foreign exchanges less unfavourable, and ultimately restore them to the normal level.

The Supreme Council appear to make no special reference to the prevailing disorganisation of transport facilities on the Continent, or to the artificial barriers to trade which various new countries, set up under the Treaty, appear to be erecting against each other. Efforts should undoubtedly also be made to overcome these contributory causes of high prices.

Whilst I have tried in this article briefly to examine the problem of high prices primarily from the point of view of this country, I trust that I have said sufficient to show that for this purpose the United Kingdom cannot be isolated from the Continent of Europe. Our economic recovery from the destruction and loss caused by the war is undoubtedly dependent to a considerable degree upon the economic recovery of the Continental participants in the war. Anything which either helps or impedes that recovery is therefore of immediate interest to us. Many of the troubles are either direct or indirect consequences of the war ; but some, it seems hardly possible to doubt, must be attributed to the terms of the Peace Treaty. Mr. Keynes's book provides a most valuable examination of this side of the problem. I strongly advise the reader to secure a copy and to study it for himself. I would give him only one word of warning—had the Treaty been as different as it could be from that actually signed at Versailles, we should nevertheless to-day be suffering from most, if not all, of our present economic ills ; no Treaty, however wisely drawn up, could wipe out in a day, or even in a year or two, the effects of five years' almost world-wide destruction. Recovery must necessarily be slow. The real economic question, so far as the Treaty is concerned, is whether its terms are likely to prejudice or to facilitate the economic recovery of Europe. Mr. Keynes has no hesitation in giving his answer to this question, and I imagine that many of those who read the book will accept his conclusions.

Will Tuberculosis Die Out?

By Louis Cobbett, M.D., F.R.C.S.

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For some centuries leprosy has been dying out in Europe, and is now all but extinct. It lingers only in a few outlying, backward places, such as parts of Norway, Russia, Spain, Portugal, Greece, and Turkey. From the more progressive countries it has entirely disappeared. From Great Britain it had practically gone at the time of the Reformation ; the last indigenous case occurred, in the Shetlands, in 1798 ; and now only an occasional instance is seen, in London or Liverpool, imported from abroad.

Yet in ancient times the disease was very prevalent. It flourished in the thirteenth century, when there were said to be over 2,000 lazarettos in France. Robert Bruce died of it in 1329. Experts tell us that there is no doubt that the disease called leprosy in the Middle Ages was the same as that known by this name at the present time—though, doubtless, other conditions were often confused with it. There can therefore be no doubt that a dreadful disease, which was once quite common here, has, in these islands at least, become extinct. Will tuberculosis go the same way—tuberculosis, which causes more deaths in temperate climes than any other infectious disease, and whose economic importance is enormously enhanced by the fact that it carries off so many of its victims in the prime of life? Will tuberculosis become extinct like leprosy?

This is no idle speculation; for already the death-rate from tuberculosis has declined so remarkably that it is now considerably less than half what it was in the middle of the last century.

But, it may be asked, can we really be sure of this? Are the figures to be trusted to the extent that we can safely compare our present returns with those of sixty or seventy years ago? Are the death-certificates of those days, on which of course the official figures are based, sufficiently accurate? May not deaths due to bronchitis or pneumonia have got put down to phthisis, consumption, or pulmonary tuberculosis (they are all one)? And do not such errors depend on ignorance, prejudice, or even custom? May it not also fairly be claimed that medical knowledge has made immense strides since those days, and that prejudice and custom, though no doubt still with us, do not take the same forms that they did? Are the statistics of to-day, then, really comparable with those of a bygone era? To put the objection concisely, it might perhaps be urged that in those more ignorant times of which we are speaking there was a tendency to put down every complaint of the lungs, and indeed of the bowels too, to consumption; and that the decline in the recorded death-rate from that cause has been due merely to continuous improvement in diagnosis. If this is so, the changes which we claim to be evidence of the dying out of tuberculosis are only changes of name. The deaths occur just the same, but are assigned to another cause.

This is a serious difficulty, and one not lightly to be dismissed; but it is too technical to be discussed here, and it must suffice to say that it has received careful consideration from a number of good authorities, and that there is substantial agreement in the conclusion that, while increase of medical knowledge and changes of nomenclature and custom have, doubtless, greatly influenced the figures, yet the errors have to some considerable extent cancelled one another (e.g. when cases of bronchitis were attributed falsely to consumption, cases of consumption also were falsely attributed to bronchitis), and that, on the whole, and especially for such large changes as we are now considering, the figures are to be depended on.

Let us, then, accept the figures as substantially accurate, and pass on to consider what they tell us. Prior to the middle of last century the records, such as they are, are very imperfect. It was not until 1871 that it became compulsory for medical practitioners to give certificates of the cause of death of every patient dying under their care. Before this the majority of deaths were certified, but as late as 1871, 8 per cent. of the total deaths lacked medical certificates. In 1904 the deficit had fallen to 1·4 per cent.

We will begin, then, with 1865, about which time the deaths attributed annually to tuberculosis began to show a decided decline. In that year these deaths numbered over 69,000. In 1913, the lowest year on record, they numbered 49,476. There had therefore taken place, in the space of about fifty years, a decline of 20,000 deaths from tuberculosis per annum, or 29 per cent. of the total in 1865.

In the meantime the population had increased by nearly 70 per cent., and the *death-rate* (or ratio of deaths to population) from tuberculosis had fallen from 3,300 per million to 1,340 per million, a decline of nearly 60 per cent.

A decline of this magnitude is an immense achievement, even if we have to take off something for the reasons which we have been discussing. If we can accomplish as much in the next half century as has been accomplished in the last one, tuberculosis will not only have been ousted from its supreme position as the most fatal of all diseases of civilised lands, but will have sunk to the level of those of secondary importance. Nay, more: let the curve which the declining mortality has followed in the past be prolonged, and it will cut the base-line before the end of the century, and tuberculosis will have become extinct. But stop a moment. Is this really so? What sort of a curve is it? It appears to be a straight line; but is it really so? Let us examine it more closely.

In the chart published by the Registrar-General, giving the annual mortality from tuberculosis since 1850, various irregularities occur from year to year. These are due to such causes as unfavourable seasons, epidemics of influenza, scarcity of food, etc., which bring about the deaths of tuberculous persons earlier than they would otherwise occur, and so cause them to fall into one year rather than into the next, to which, under perfectly uniform conditions, they would naturally belong. Since these irregularities in no way concern us now, and are indeed disturbing to our present purpose, I have calculated the mean annual mortality from tuberculosis for successive periods of five years, and, having labelled each with the central year of the group, set them in order in the form of the chart which follows, where each column is proportional to one of these quinquennial means.

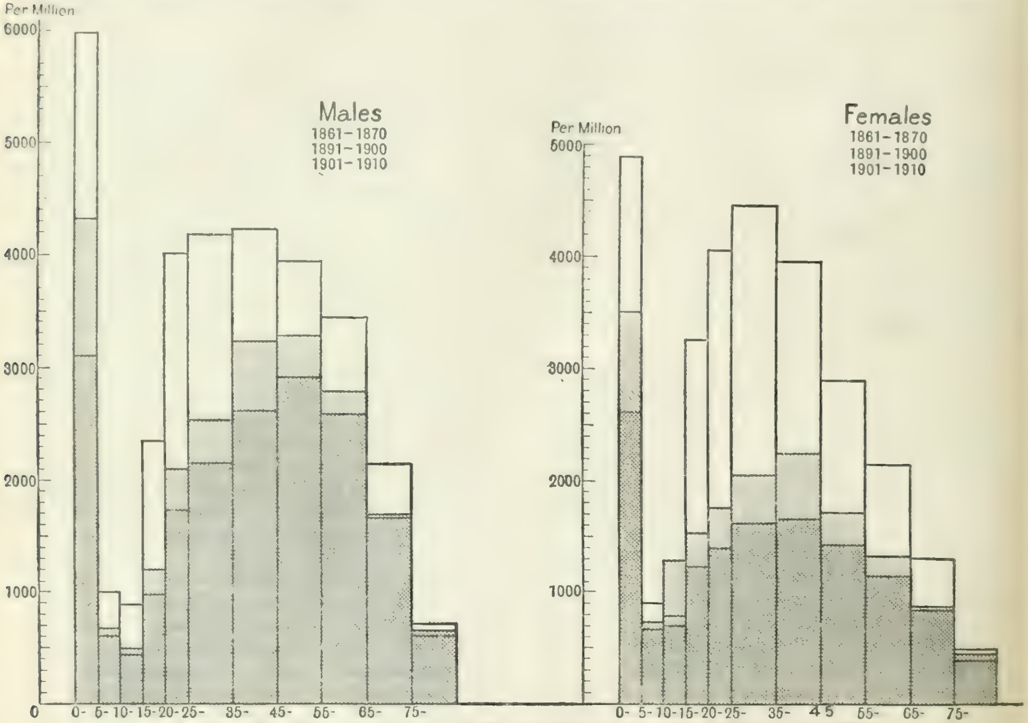

FIG. 1.—THE MEAN ANNUAL DEATH RATE FROM TUBERCULOSIS IN ENGLAND AND WALES IN SUCCESSIVE (OVERLAPPING) "PERIODS" OF FIVE YEARS.

Even when this has been done, irregularities have not been entirely eliminated, but they have been so substantially reduced that it is comparatively easy to see the general trend of the curve. That curve appears, at first sight, to be a straight line, which, if prolonged, would reach the base somewhere about 1950. A decline following a straight line means, of course, an accelerating rate of dimunition; for it implies a fall of the same absolute amount each year, and this constant decrement must bear an increasing ratio to the declining totals. A constant rate of decline, on the other hand, follows a curve with a convexity downwards, a curve which is always flattening out, always approximately to the horizontal, and never reaches the base-line at all. For if you halve an apple, take away one part, and halve the remainder, and continue this process, there will always be something left. Of which sort is our curve?

The fact is that the rate of the decline of the death-rate from tuberculosis up to 1914 was not a constant but an accelerating rate. Nevertheless the acceleration was not such as to produce quite a straight line. The curve does indeed show a tendency, though a small one, to flatten out; and the complete extinction of tuberculosis may, therefore, be farther off than the chart at first sight seems to indicate. But it must be remembered that tuberculosis would be much easier to deal with were there not so much of it, and that its last remnants should be easily stamped out by segregation. We may look forward, therefore, to the problem becoming progressively more manageable as time goes on. After all, then, we need not worry ourselves much as to the exact shape of the curve: the main point is that the extinction of the disease is within sight.

Though the promised land may be obscured by mists which diminish visibility and make it difficult to estimate its distance, yet we command a Pisgah height from which the eye—aided no doubt a little by the telescope of imagination—can see the curve of the mortality from tuberculosis steadily approaching its base-line, and, somewhere away near the horizon, we don't quite know how far off, but at least within the range of assisted vision, actually joining its base-line and extinguishing itself in it. When we arrive there tuberculosis will have gone the way of leprosy and have become extinct.

But the causes which have brought about this fall, will they continue to act? May it not be that they have already nearly exhausted their influence? What were those causes? Are they of a nature likely to be permanent? Moreover, may not other causes, possibly, come into action which will reverse the process?

Such a cause was the war. In the year 1913 there were 49,476 deaths from tuberculosis; in 1918, the latest year for which I have the figures, there were 58,073, an increase of 8,597 deaths from tuberculosis of all kinds. (But as a matter of fact the increase was entirely an increase of pulmonary tuberculosis, deaths from other kinds of tuberculosis having actually decreased.) For so bad a year we must go back to 1904, so that the war may be said to have set us back fourteen years, and probably we do not know the worst yet.

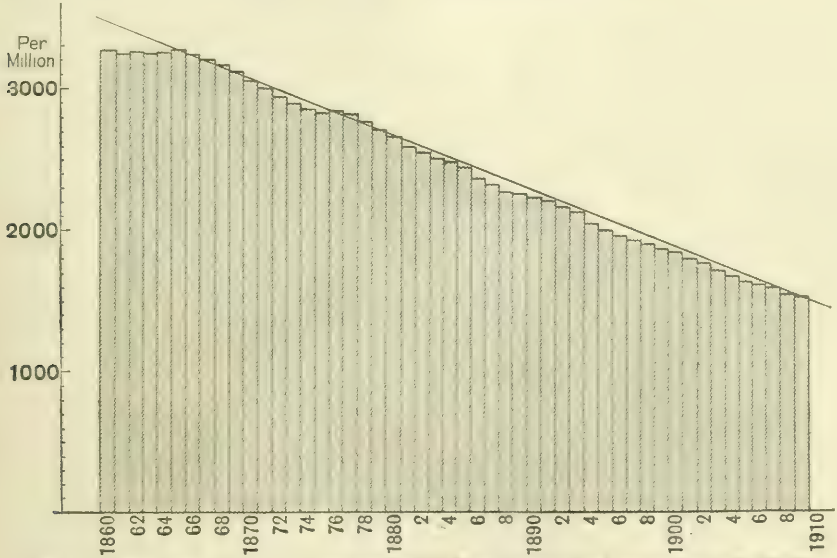

FIG. 2.—ILLUSTRATING THE FALL IN THE MORTALITY FROM TUBERCULOSIS AMONG MEN AND WOMEN.

The war has exerted its influence on tuberculosis, both in the army and in the civil population. Many persons thought that the open-air life of the soldier would prove beneficial to those in the early and unrecognised stages of consumption. But it was not so. Above all things the consumptive needs is to be taken care of and protected from hardship, even in the earliest stages of the disease. Though plenty of fresh air is, no doubt, a good thing, it will not make up for exposure and fatigue, which are the very worst things. Many a case of infection with tubercle bacilli which, but for the war, might have done well was converted, by active service conditions, from a retrogressive into a progressive tuberculosis. Many a case of quiescent lung trouble broke down under the strain and ended fatally in consumption.

But the civil population suffered also, and more than the army, from this cause, because the great majority of early consumptives were left at home. Let us see how the various constituent elements of the home population were affected.

While deaths from tuberculosis increased among both sexes, it was the women who were more particularly affected, and especially the women at the most active periods of life. Why was this? The answer is easy. The key is given by the fact that during the years before the war, when tuberculosis was slowly dying out, it was the women who were gaining all the time far more than the men. Once, more women died of tuberculosis than men. They do so still in backward Ireland. But in England the preponderance of deaths was transferred from women to men in 1868; in America the change took place about ten years later, and in Scotland later still. This rate of change corresponded with the rise of the industries in the respective countries. Many trades, from the nature of the dust they produce, or from other causes, are injurious to the lungs, and predispose to tuberculosis. This is notably the case with tin-mining, tool-grinding, and pottery-making, and there are many others; but it is a curious thing that nearly all those trades which predispose to tuberculosis are followed by men, and not by women. This fact it is which has caused the tuberculosis mortality to fall so much more profoundly among women than among men. It may be said that *tuberculosis has declined in spite of the adverse influence of industrialism*,[1] but the decline has been from this cause retarded chiefly among men, especially at the ages between 35 and 65; and between 45 and 55 the decline among men has been little more than half as great as it was among women at the same ages.

Fig. 2 will show how the fall in the mortality from tuberculosis has affected the two sexes at different ages. The figures along the base-line represent ages, the whole period of life being divided into eleven periods, five of them, in the earlier part of life, of five years each, and the rest of ten years each. There is a column for each age, and the two sexes are shown separately. Each column is divided into three parts. The upper limit, measured from the base-line, gives the mean annual mortality from tuberculosis for the decade 1861–1870. The second limit, also measured from the base-line, gives that for the decade 1891–1900. And the third limit gives the same information for the decade 1901–1910. Thus we can see at a glance how each sex has benefited at each period of life. Up to fifteen the boys have gained rather more than the girls, but during the working years the gain has been all on the side of the women, and the longer industrial conditions have had to tell, the greater is the disproportion.

The ratio of the amount of decline among females to that of males during the whole period under consideration is given by the figures below.

It is only necessary to recognise the adverse conditions which, so far as tuberculosis is concerned, industrial life has in the past exerted on the males to see why war conditions have had so great an effect upon the mortality from tuberculosis among women. They went in large numbers into factories for the purpose of making munitions. They did work which only men had done before, and they began to be subjected to the adverse conditions which hitherto had affected the men alone.

The infants suffered least, or rather they did not suffer at all, but the decline in the death-rate from tuberculosis from birth to the fifth year of age, which had been progressing rapidly, especially since the beginning of the present century, continued as though no war had been going on. The rate increased a little among the younger children over five years of age, and it increased rather more among the older children. Why was this? It was, probably, because of the shortage of food, especially of fatty food, and especially of milk. Whatever happened the baby was to receive its proper quantity. If there was not enough to go round, the children might go short, and it was the older children, rather than the younger ones, who had to suffer.

The experience of the recent past, indeed, has strongly emphasised the importance of food in tuberculosis. In parts of the Continent where semi-starvation or worse has been prevalent, as in Vienna, tuberculosis has run riot. A friend who was a prisoner of war in Germany, in a camp where there were also many Russians, tells me that while the British, who were well supplied with parcels of food from home, remained well, the Russian prisoners, who had no such resources, were dying like flies from tuberculosis. From all accounts we hear that it was the shortage of fats, especially of milk and butter, which produced these results. And we cannot be surprised at this. Is not cod-liver oil the staple remedy for consumption?

In the decline of tuberculosis which went on so steadily before the war many causes are thought—and no doubt justly—to have contributed. Decrease of overcrowding (brought about by better housing), politer manners, higher wages (conducing to greater comfort generally, especially more plentiful and more nourishing food), the cult of the open window, all these have played their part. For tuberculosis, though indeed it

Ratio of Female to Male Decline in the Death-rate from Tuberculosis between the Decades 1861–1870 and 1901–1910, the Decline among Males at each Age being taken as 100.

Ages.	All ages.	0–5,	5–10,	10–15,	15–20,	20–25,	25–35,	35–45,	45–55,	55–65,	65–75
Ratios	**128,**	**96,**	**68,**	**94,**	**107,**	**114,**	**129,**	**150,**	**196,**	**184,**	**154**

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[1] In rural districts of England and in Ireland, in 1908, the death-rate from pulmonary tuberculosis was very much the same among men and women. But in industrial centres, like Sheffield and Birmingham, the death-rate from this cause during the active working years of life, and especially of its later half when industrial conditions have had time to tell, is twice or nearly three times as high among the men as among the women.

spares no class, falls heaviest on the poor. Poverty, overcrowding, dirty habits, bad ventilation, poor feeding, are the causes of tuberculosis, and the causes of its decline have been well summed up in the phrase, *The amelioration of social conditions*.

But when all these causes of tuberculosis are taken into consideration, two stand out predominantly among the rest—overcrowding and bad feeding. Overcrowding favours the passage of infection from the sick to the healthy, and bad feeding predisposes the latter to the disease. Thus one cause sows the seed and the other prepares the soil; for without preparation the seed of tuberculosis will not flourish.

The causes of the decline of tuberculosis are by no means nearing exhaustion. Not yet does everybody receive as much food as he can do with, and that of the most suitable kind and quality. How our fathers lived it is difficult to understand. Underfeeding must have been the rule, something like famine common. Progress in agriculture and importation of foreign food has done much, and, compared with what was the case a century ago, our poorer classes live like fighting cocks.[1] But we have not yet seen the end of the movement, and we must not think that there is no need for further improvement in the feeding of the people. Much also remains to be done in the matter of education, and in health-education, before overcrowding will be extirpated, and people have learnt not to facilitate the spread of infection from the sick to the healthy. We are therefore not at the end of our resources. Far from it. Much remains to be done on the lines which, there is good reason to think, have brought down the tuberculosis mortality so wonderfully in the past.

Doubtless the present high prices and lack of houses are keeping up the adverse conditions begun by the war. But these will yield to time; and once more we may expect to see the tuberculosis mortality continuing its steady decline until the disease has sunk to the status of an uncommon infection. And this, too, will be only a stage before its complete eradication. Tuberculosis will go the way of leprosy and become extinct.

NOTE.—Further information on this subject may be obtained from a book by the present writer entitled *The Causes of Tuberculosis*. (Cambridge University Press, 23*s.* net.)

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[1] Gilbert White, in a letter to the Hon. Daines Barrington dated 1778, and published in his *Natural History of Selborne*, gives an interesting account of the progressive improvement of the food of the people, which was evident even at that date, and attributes the disappearance of leprosy very largely to this cause.

Textbook of Inorganic Chemistry. Vol. ix, part i. By J. NEWTON FRIEND, D.Sc. (Griffin, 18*s.*)

The Class-Room Republic. By F. A. CRADDOCK. (Black, 2*s.* 6*d.* net.)

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Professor of English in Armstrong College, Newcastle-on-Tyne

AMONG recent developments in English linguistic studies, none is more marked or likely to be more fertile in results than that which has taken place in the study of our place-names and, incidentally, of our personal names.

Interest in the meaning of the names of those places with which we are in daily contact is innate in most of us, and, from the earliest times, attempts have been made to interpret them. Sometimes, as in the modern *Bear Park* (co. Durham) for earlier *Berper* (from O.Fr. *beaurepeir*, " beautiful retreat "), we have simply a case of folk-etymology; but in others more alluring methods of interpretation, by means of some picturesque legend, have been adopted. Thus *Dukesfield* (near Hexham) is commonly explained as the field where the Duke of Somerset was captured and executed after the Battle of Hexham in 1464, regardless of the fact that it is found as *Dukesfeld* in 1296; or *Brancepeth*, commonly written and pronounced *Brawnspeth* in the eighteenth century, is made the final stage of a great hunting of a *brawn* or boar, which began at Ferryhill and ended here, though *Brawnspeth* is the perfectly natural development of a twelfth-century *Brandes-peth*, i.e. Brand's path.

It was not until the beginning of the present century that deliverance from these fascinating but unscientific methods of explanation first came. In 1901 the late Professor Skeat wrote a little volume on the *Place-Names of Cambridgeshire*. In it he laid down for the first time, in England at least, what must be the guiding principles of all place-names study, viz. (1) that place-names can only be interpreted in the light of earlier forms; (2) that the interpretation of these forms can only be undertaken satisfactorily by the skilled philologist. Thus *Cambridge* itself is not the " bridge over the Cam," but the " bridge over the Granta." The earliest form is *Grante-brycg*, and this by a succession of well-established sound-changes became *Cantebrugge, Canbrigge, Cambrugge, Caumbrege, Cambryge*, until at last people began to say to themselves, " Surely there must be some mistake, *Cambridge* must be named from the river on which it stands; the proper name of the river is clearly not *Granta* at all, but *Cam* "; and so in the end *Grantbridge* became *Cambridge* and *Granta* became *Cam*.

The next great advance came when in 1911 Professor Wyld, working in collaboration with Dr. Hirst, brought out his *Place-Names of Lancashire*. He developed the principles laid down by Skeat, and put even more stress on the necessity of the work of the trained phonologist in interpreting the forms in use from the earliest found in MS. records down to the latest heard locally from the lips of present-day Lancashire people. A good example of his methods of work is seen in his treatment of the name *Liverpool*. Here we have the crux of four well-established forms of the name existing side by side in the sixteenth century, viz. *Liverpool, Leverpool, Litherpole, Lerpoole*. Wyld shows how the first two and the last are perfectly regular phonological developments of an early *Lēofhere's pool*, while the third is only another example of false analogy. No reasonable interpretation could be offered of *Liver-pool*; there is a *Lither-land* a few miles down the river, which in the sixteenth century would readily be interpreted as " foul-land," so why not imagine that *Liver-pool* was a mere blunder for the *lither* or dirty pool, and correct it accordingly?

Almost at the same time that Wyld's work appeared, the late Dr. Moorman brought out his study of the *Place-Names of the West Riding*. Here new ground is opened up in the attempt made in its " Historical Introduction " to deal with some of the larger problems which lie at the back of our place-nomenclature, problems of race, settlement, civilisation, etc. Any such attempt was probably premature, for these problems can only be dealt with satisfactorily when the evidence for the whole of England has been collected and sifted, but it is important that this side of the question should be kept alive. Another suggestive book on these lines is the essay on the *Place-Names of Berkshire* by Professor Stenton, of Reading. It is well worthy of study as a moderate and well-balanced statement of all that the development of place-name study may mean for the student of history. Hengest may or may not have been a real person, but it is well to note how popular this hero must have been when his name, otherwise unknown in historical times, is found, as Stenton points out, as the first element in Hinksey in Berkshire, Hinxston in Cambridgeshire, Endscot in Devon, Hinxworth in Hertfordshire, Hinksford in Staffordshire; and, we might add, Hingeston Down in Cornwall, and Hinxhill in Kent.

Of the other writers who have dealt with the place-names of any particular county, and have at the same time suggested new lines of investigation, we may mention three. Baddeley, in his *Place-Names of Gloucestershire*, includes a good many notes of interest on Middle English names which have now disappeared from the map. Ekblom, in his *Place-Names of Wiltshire*, is one of the few scholars who make any serious attempt to deal with the many problems that arise from a study of Anglo-Saxon Charters. Goodall, in his *Place-Names of South-West Yorkshire*, makes a bold attempt to deal exhaustively with the names found in a certain limited area.

Finally, in any attempt to characterise the various types of place-name work that have been undertaken, mention should be made of the fact that Professor Wyld and his pupils (in their books on the *Place-Names of Oxfordshire, Derbyshire, Nottinghamshire*, and *Sussex*) write definitely and exclusively from a philological point of view. They leave for later settlement by the historian and the topographer the question as to whether their explanations are in accord with the facts of history or topography. Whether that is wise we need not discuss here. All that we need say is that, in the light of this wider knowledge, there is no doubt that many of the explanations now given will have eventually to be abandoned.

Side by side with place-name study there has developed, as its necessary concomitant, study of our personal names. A large proportion of our place-names are, so far as their main theme is concerned, derived from the names of their sometime settlers, owners, or occupiers, and these can only be properly identified when we know more of the history of our personal names. The late Dr. Searle compiled an *Onomasticon* containing a list of all Old English names found before 1100, but it is essentially unscientific, and included many names that are not English at all, and a good many ghost-names. Much has been done to remedy this by Scandinavian scholars. The late Professor Björkman, of Uppsala, did brilliant work on Old and Middle English names of Scandinavian origin in his *Nordische Personennamen in England* and *Zur Englischen Namenkunde*. Two of his pupils have dealt very thoroughly with other themes—Dr. Forssner with *Continental-Germanic Personal Names in England*, and Dr. Redin with *Uncompounded Personal Names in Old English*.

One other subsidiary study must be mentioned. A large proportion of the forms on which we are dependent for our work are preserved in documents—*Charter Rolls, Patent Rolls*, and the like—written by official scribes who were much better skilled in Anglo-French or in Latin than in English. The student of these documents is greatly hampered by the strange vagaries in the spelling, and even in the pronunciation, of place-names which have resulted from this. Scandinavia has again come to the rescue in the person of Dr. R. E. Zachrisson, whose book on *Anglo-Norman Influence on English Place-Names* must be the vade-mecum of anyone who attempts to take up these studies.

Here, then, we have a record of experiment on various different lines, of much essential preliminary spadework in allied fields of study, and, at least on the face of things, a goodly record of definite accomplishment. Let us consider briefly what remains to be done if work on English place-names is to be carried to a successful conclusion.

[*Continued on p.* 154

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In the first place it is important to realise that, though work has already been done on some twenty counties and on one of the Yorkshire Ridings, much remains to be done even here, and mainly for two reasons. First, the books published deal in the great majority of cases with only a small proportion of the names that call for explanation. Secondly, quite apart from any individual weakness or idiosyncrasy on the part of their authors, each of these books suffers from a weakness entirely beyond their control—viz., that it is impossible to deal satisfactorily with the evidence for any single county until that for all other counties is available also. For these reasons alone it is clear that much fresh work will have to be done on these counties before anything like finality can be attained, and there are still some eighteen counties and two-thirds of Yorkshire untouched.

For the proper treatment of the old and new areas alike, new and extended lines of work are gradually suggesting themselves. In the first place, a much more thorough and exhaustive study than has hitherto been attempted must be made of local pronunciations, so far as they have survived. Often the ultimate solution of the history of a place-name depends upon a knowledge of such a local pronunciation, and it is becoming increasingly hard to discover the existence of such. False ideas of what constitutes an educated way of speech in this matter are tending to drive them out in favour of forms based on the written word. Here much help may be obtained from a study of sixteenth, seventeenth, and eighteenth century Parish Registers, many of which have been reprinted, and many more of which are available in typewritten or MS. transcripts. Luckily for us, the average parson of those days did not travel far, could not study ordnance maps, and was not a pedant in matters of spelling. When a marriage took place at Corbridge, and the bridegroom came from Alnham, the Vicar wrote what he heard, viz. that the bridegroom came from *Yeldham*; or when a child born at Coniscliffe was baptised at Newcastle, his birthplace was recorded as *Cunsley*. Again and again the first trace of such local pronunciations has been found in entries such as these and suggested grounds for further inquiry. That the ultimate solution of a name may often depend on a knowledge of such a pronunciation may be illustrated from the history of *Haltwhistle*. From 1240 onwards we find spellings such as *Hautwisel*, *Hawtetwysill*, and it is not till 1479 that we find one with *l*, such as *Haltewesyll*. This completely puzzled the present writer until in the Corbridge Parish Register for 1655 he came upon the form *Hoatewhisle*. This put him on the track of the still existing local pronunciation, " Hoatusle," and it was at once clear that here, as in Ault Hucknall, Derbyshire, the first element is Old French *haut*, high, with later intrusion of *l*, due to learned folk who knew its connection with Latin *altus*. Soon, as in the common word *fault*, earlier *faute*, the new spelling form prevailed, and, except on the lips of the people of the countryside, ousted the linguistically correct form. *Haltwhistle* is " the high ground at the *twisle* or forking of Haltwhistle Burn and South Tyne."

For these reasons it is much to be desired that all existing records should be ransacked for such phonetic spellings, and that those who have had the requisite phonetic training should, in the course either of their work or play, make note of all local pronunciations with which they come in contact, and get them placed on exact record before it is too late.

Further, England is incomparably rich in historical documents which provide early forms for the study of place-names. For our Old English charters we are still almost entirely dependent on the eminently unsatisfactory editions of Kemble and of Birch. The fact that there is no good edition is not, however, any excuse for the comparative neglect of these fundamental documents by many of our writers on place-names, and it is sincerely to be hoped that ere long those possessed of the necessary philological and palæographical knowledge may give us the editions we so sorely need.

The lengthy series of *Calendars of Charter Rolls*, *Patent Rolls*, and other documents issued under Government authority are unluckily marred, especially in the earlier volumes, by lack of local topographical knowledge. Students of local history working through these volumes could do much to help the writers on place-names by tackling the problem of the identification of many of them. The indexes of these volumes are full of unidentified names and of names that have been wrongly identified.

Finally, one of the great difficulties in English place-name study is the fact that we have to deal with names given by a succession of settlers of varying race and language. Knowledge is needed not only of English in all its stages of development, but also of Anglo-French and of the various Scandinavian and Celtic languages. No single scholar can hope to deal with all these problems. Hitherto a certain amount of help has been received from specialists in Anglo-French and Scandinavian, but no one has attempted to deal with any of the Celtic problems which clamour for attention, except Ekwall, in his recently published *Scandinavians and Celts in the North-West of England*. At present writers on place-names must of necessity either omit these difficult names altogether, or give their forms with no word of comment of explanation.

Such are three only of the many new vistas of study which open up before us if we once begin to think how to carry through the work that still remains to be done, and the lesson to be drawn from them all is how hopeless is the future of place-name study in England unless we secure some measure of co-operation and co-ordination in its future conduct. If left to himself the scholar will continue his more or less haphazard methods of selection and treatment, and no scholar working by himself can hope to compass the necessary study of the place-names of England as a whole. For the collection of local forms, the critical study of Old English charters and documents generally, for light on problems in those languages with which he is not familiar, he must have at his command channels of information with which he can at present only get into touch, if he does so at all, with much trouble and a good deal of luck. The how, the when, and the where of such co-ordination and co-operation cannot be discussed here. For the moment let us realise its necessity if the study of English place-names is ever to become in the fullest sense of the term "scientific."

The chief books on single counties are published as follows:—The Cambridge University Press: Goodall, *Place-Names of South-West Yorkshire*; Mutschmann, *P.N. of Nottinghamshire*; Roberts, *P.N. of Sussex*. Oxford University Press: Skeat, *P.N. of Berkshire*; Alexander, *P.N. of Oxfordshire*. Milford: Duignan, *P.N. of Staffordshire, Worcestershire, and Warwickshire*. Manchester University Press: Sedgefield, *P.N. of Cumberland and Westmorland*. Constable: Wyld and Hirst, *P.N. of Lancashire*. Bellows, Gloucester: Baddeley, *P.N. of Gloucestershire*. Skeat's volumes on *Cambridgeshire, Bedfordshire, and Suffolk* were published by the Cambridge Antiquarian Society, and can be purchased through Messrs. Deighton Bell or Messrs. Bowes & Bowes. His notes on *Huntingdonshire* are to be found in vol. x of the same Society's *Communications*. His *P.N. of Hertfordshire* was published for the East Herts Archæological Society by Stephen Austin & Sons, Hertford. Moorman's *West Riding Place-Names* formed vol. xlviii of the publications of the Thoresby Society. A book on the *P.N. of Northumberland and Durham* by the present writer is now at press at Cambridge. Stenton's *Essay on the P.N. of Berkshire* is published by University College, Reading; and Walker's "P.N. of Derbyshire" appeared in the *Journal of the Derbyshire Archæological and Natural History Society* in 1914 and 1915.

In Sweden have been published: Ekblom, *P.N. of Wiltshire* (Appelberg's Boktryckeri, Uppsala); Lindkvist, *Middle English P.N. of Scandinavian Origin*, Part I (Akademiska Bokhandeln, Uppsala); Zachrisson, *Anglo-Norman Influence*; and Ekwall, *Scandinavians and Celts* (C. W. K. Gleerup, Lund). All these are written in English.

Excellent introductions to the study of personal names will be found in Weekley's *Romance of Names* and the same author's *Surnames*.

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Musical Sands

By Cecil Carus-Wilson, F.R.S.E., F.G.S.

For some centuries past travellers and others have referred from time to time to the existence of sands which, under favourable conditions, produce mysterious music, and many of these references may be found in my paper on "Musical Sand," read before the Bournemouth Society of Natural Science in 1888.

Up to 1850, when Hugh Miller discovered musical sand at the Isle of Eigg, there were but two other generally well-known localities where these sands occurred. These were Jebel Nagous, or "Mountain of the Bell," in the desert of Mount Sinai, and Reg Ruwan—or Rig-i-Rawan—the "Moving Sand," about forty miles north of Corbul.

The former had been visited by Seetzen in 1812, and by Gray, Ehrenberg, Wellsted, Newbold, and others subsequently, and the latter by Sir Alexander Burns in 1836.

Since Hugh Miller's time, however, musical sands have been found on beaches at many places. Professor Bolton and Dr. Julien, through the Smithsonian Institution in 1884, recorded their occurrence at no less than seventy-four localities on the Atlantic coast of the United States. Since discovering these sands at Studland Bay in 1888, I have found them at many places, and other observers have also added to the list.

My observations and researches have been carried out with the musical sands found on sea-beaches and those produced artificially in the course of my investigations only, since I have been unable to visit any of the desert examples referred to.

Lieutenant Newbold visited Jebel Nagous in 1840 and made some most interesting observations. His Bedouin guide ascended the slope, and the loose sand thus set in motion produced "a faint musical sound resembling the deeper chords of a violoncello at a distance." Newbold and his friend Mr. Shute then climbed up the face of this loose sand and seated themselves "at the base of the mural cliffs which crest the summit," and from this point they watched the sand they had set in motion roll down the slope "in gradually widening lines to the base." "The disturbance of the upper layers of sand went on increasing on every side, somewhat resembling the effect produced on the surface of still water on dropping a stone into it. . . . About two minutes after the sand had first been set in motion a faint rustling sound, as it rolled down, struck our ears; then the low, deep, distant, musical tone we had first heard, which generally became more and more distinct, and apparently nearer, in successive and fast-repeating notes, whose sound partook of those of a deep, mellow church or convent bell, and of the vibrations of a stringed instrument." Newbold then disturbed the sand near the summit with his feet, and the notes became higher and more prolonged, "resembling the wild strains of an Æolian harp, but gradually becoming deeper and louder, until at length they rivalled the continued rumbling of distant thunder," and caused the sand on which they sat to tremble in distant vibrations. The sensations experienced were similar to those one might expect to feel if seated on the body of some gigantic stringed instrument while the bow was being slowly drawn across the strings.

Newbold's opinion on the cause of these remarkable effects concided with that of Lieutenant Wellsted, a former observer in 1830. They believed the sounds were due to the action of the wind upon the waves of sand as they flowed down the slope. In my paper of 1888 I showed that this explanation was untenable.

In 1889 Professor Bolton visited Jebel Nagous, and made observations which were graphically described in a paper read before the American Association for the Advancement of Science.

As one might have expected, similar sounding sands occur in other parts of the desert where the same conditions prevail, and Professor Bolton discovered another example which Dr. Julien named "Bolton's Bell Slope." In 1912 Mr. Harding King referred to similar phenomena occurring in the Libyan Desert.

Another noted example is the El Bramador, or "Roarer or Bellower," in Chili, mentioned by Darwin in 1835, and described by Mr. M. H. Gray in *Nature* in 1909. The "Barking Sands" of the Hawaiian Islands are also well known.

It would appear from these, and many other references which it is unnecessary to give now, that the effects produced by the accumulations of loose sand are similar in all cases, and differ materially from the sounds emitted by the musical sands of beaches when struck or agitated by artificial methods.

Describing the musical sands of Eigg, Hugh Miller wrote: "I struck it obliquely with my foot, where the surface lay dry and incoherent in the sun, and the sound elicited was a shrill, sonorous note, somewhat resembling that produced by a waxed thread when tightened between the teeth and the hand and tipped by the nail of the forefinger."

In 1884 Professor Bolton and Dr. Julien conducted some interesting experiments on the "singing beach" at Manchester-by-the-Sea, Massachusetts, with a view of arriving at some definite conclusion in regard to its peculiar characteristics.

Hugh Miller found that the loudest sounds were produced by drawing the hand slowly through the incoherent sand on the beach at Eigg, while Professor

Bolton thought they were produced by placing about a quart in a bag and striking it, the sounds thus elicited being heard at a distance of 450 feet.[1]

Professor Bolton and Dr. Julien published a theory to account for the cause of the phenomenon. They believed that the individual grains of sand were surrounded by films of condensed air, and that these acted as elastic cushions, enabling the grains to vibrate separately when disturbed. Thus they would behave like microphonolites when struck; but there are many insuperable objections to this theory.

In 1886 I commenced my investigations with a view to discovering the cause of the sounds, and was finally led to believe that they were due to the rubbing together of millions of clean and incoherent grains of quartz, with no angularities, roughness, or adherent matter investing the grains; and that, though the vibrations emitted by the friction of any two grains might be inaudible, those issuing from millions, approximately of the same size, would give an audible note. Working on this supposition, I produced in 1891 notes from a treated sand that was not previously musical.[2]

The highly musical Eigg sand can be rendered mute by adding a certain quantity of dust or purely angular grains, and certain mute sands may become musical by eliminating dust or angular grains. Again, completely spherical grains will not produce music.

After all, it is the proportionate presence of the different mineral fragments that decides the purity and intensity of the notes, other conditions being favourable. We can easily suppose that sand possessing all the necessary conditions in great perfection will be most musical, while those sands possessing all, or some, in less degree, will emit sounds decreasing in musical qualities in proportion to the decrement of the essential factors, severally or in combination.

Sound is the result of a series of pulsating waves of air, or vibrations, which impinge upon the tympanum or drum of the ear successively. When these vibrations are irregular we get noise; when they succeed each other with sufficient rapidity, and at regular intervals in a given period of time, the noise becomes music.

If we take a sand composed of quartz and other grains which are more or less angular, and vary considerably in size, and strike it in a cup with a wooden plunger, we get *noise*. But a musical sand composed chiefly of quartz grains which are more or less rounded and sub-angular, are well polished, and vary but little in size, when struck in the same way produces *music*. In the first case we get irregular vibrations, and in the second case regular vibrations.

[*Continued on p.* 158

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[1] Some of my own observations and experiments at Eigg were referred to in *Nature*, June 15, 1911.

[2] *Nature*, August 1891.

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Now as to the origin of these regular vibrations from sand grains: If we draw the point of a pen vertically over the surface of a piece of glass, friction puts a drag on it and tends to stop its progress. But the point meets the increasing obstruction by finally jumping over it, so that it progresses by means of a series of regular "running jumps," so to speak, and these give rise to the regular vibrations that produce the squeaks emitted.

If we increase the number of steel points we increase the volume of sound.

Now let us suppose that a number of sand grains, complying with the requisite conditions, rub against each other when in motion, and produce a number of vibrations of equal length. They would then produce a musical note.

The quality and intensity of the notes emitted by musical sands depend largely upon the shape and composition of the receptacles in which they are tested. A porcelain cup gives good results, but when the same sample is similarly treated in a flower-pot, a cardboard box, or a rubber vessel, it is practically mute. Pour it back into the porcelain cup and it is as musical as ever! We may assume that these remarkable results are due to the fact that in experimenting with small quantities of sand their efforts to produce music need assistance. This they obtain when the grains move freely against the sides of glazed porcelain or smooth wooden vessels. They possess greater mobility in such vessels. In the case of a flower-pot, box, and rubber receptacle, these encouraging factors are absent. Compression, too, produces compaction, and therefore loss of coherency in the sand. As the flower-pot is smaller at the bottom than at the top, the sand is compressed when struck, thus depriving the grains of the freedom to move one over the other.

Coherency is also destroyed by wetting. Sand that is quite musical when dry may be rendered mute by wetting.

In regard to the plungers: Some are good for the purpose required and others bad. A beech-wood ninepin, a deal paint-brush handle, and a glass pestle, are good. Rubber, cork, and lead are bad. I call these positive and negative plungers. Some cylinders, such as glass and metal, are positive, and some negative plungers will give feeble results on a fresh patch of musical sand *in situ*.

A positive plunger may be rendered negative by covering the striking end with rubber. A negative plunger may sometimes be rendered positive by what I call "coaxing." Thus, a negative cork will become positive if we screw a porcelain knob into one end. Also, a negative cork may produce positive results if fixed in the end of a piece of one-inch iron piping.

I have stated elsewhere that the pitch of the note produced by a plunger is determined by its bulk and the area of its striking surface. The striking surface of a beech-wood plunger nearly an inch in diameter, when plunged into the sand in a porcelain cup, emits a note of a certain pitch. A smaller plunger, having a striking surface of about half an inch in diameter, gives a note of much higher pitch.

With a rolling-pin and a large basin of musical sand we can produce a deep note like the baying of a large dog, and with a lead pencil a note like a shrill whistle.[1]

But it is important to observe that the pitch of a note may be varied at will by increasing or decreasing the bulk of the plunger. If we screw a brass knob on to the upper end of a plunger, the pitch is considerably lowered, though the area of the striking surface is unaltered.

I believe that the positive plungers vibrate in sympathy with the vibrations produced by the sand grains, and, acting as resonators and intensifiers, are responsible for the greater part of the sound we hear. The late Professor Poynting, who took considerable interest in some of these experiments, thought so too.

Thus the pitch of a note does not depend only upon the area of the striking surface, but rather upon the size or bulk of the plunger, other things being equal.

A large plunger vibrates less rapidly than a small one, and so produces lower notes. We may use a plunger which, if vibrating, would always emit a constant note. At one end we may have a large surface, and at the other end a small one. But whichever end is used for striking the sand, the pitch of the note remains the same. A plunger made to fit together in two parts acts in the same way.

Another curious fact is that if we take two positive plungers, giving a low note and high note respectively, and strike the sand with both simultaneously, no note is produced.

This is probably due to interference setting up general confusion in the vibrations, and so destroying the usual effect, which appears to suggest that it is the plungers rather than the receptacles which act as resonators.

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[1] See *Nature*, July 15, 1909.

Wireless Telegraphy and Telephony. By H. M. DOWSETT. (Wireless Press, 9s.)

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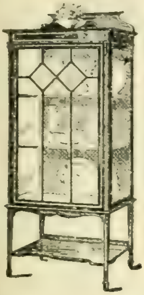

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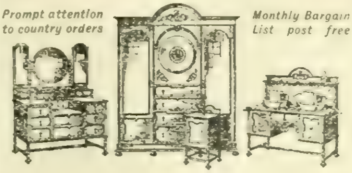

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Editorial Notes

An interesting description of the Air Routes of the Empire was given recently before the Royal Geographical Society by Major-General Sir Frederick Sykes, Controller-General of Civil Aviation, and by the courtesy of the Editor of the Society's publication, the *Geographical Journal*, we are allowed to give some notes on the lecture, and to reproduce some of the sketch-maps shown.

* * * * *

In considering the general development of Imperial air routes, one of the first things that appears is that for some time to come Egypt must be the "hub" of the India, Australia, and Cape routes. It is, in Sir Frederick Sykes' phrase, the Clapham Junction of air routes. Our own country, being, so to speak, on the edge of a continent, is barred geographically from occupying this position; and furthermore our climate, and especially our fogs, tend to hinder successful flying. Fortunately, however, parts of the Empire are wonderfully wisely distributed over the surface of the earth, so that unequalled positions for the establishments of depots, fuel bases, and for meteorological and wireless stations are at hand in almost every part of the world.

* * * * *

It is clear that, before an air route is established between two places, the ground between must be carefully gone over and sites for depots chosen. These sites must be very carefully selected and equipped, so that an airman may get what he requires on his journey. Routes must be selected which involve the least risk to the flyer. Mountainous country and very large stretches of sea, for example, should be avoided, if that be possible. It is also expedient, if circumstances allow, to avoid flying over foreign lands unless a perfectly good understanding about the matter exists. In Europe, of course, an all-red route is impossible.

In the past two or three years the preliminary work has been done, the routes have been selected, depots and aerodromes have been stationed along the routes, and many of the suggested journeys have been successfully flown.

* * * * *

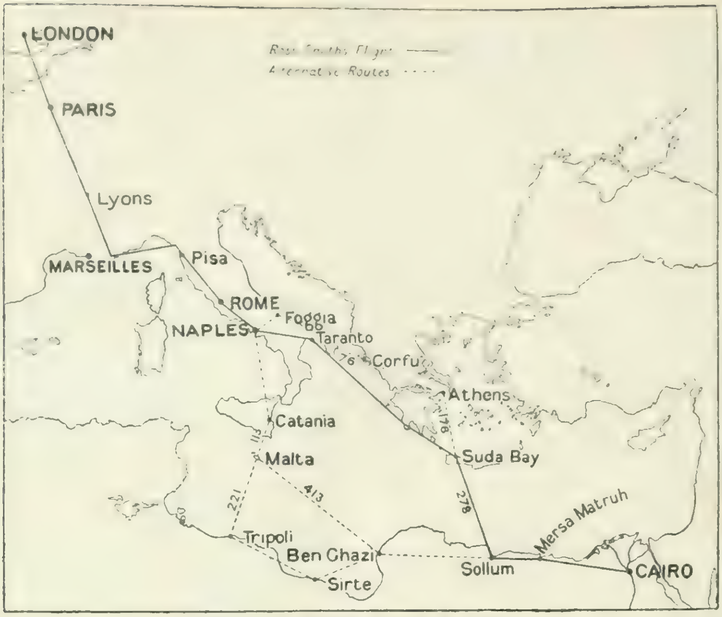
Let us next consider the actual air routes themselves. The journey from England to Egypt was first accomplished in November 1918, by Generals Borton and Salmond. Although it has been flown many times in the past two years, it is by no means an easy journey. The accompanying map shows the route clearly. The continuous line is the course taken by Sir M. Ross-Smith, the dotted lines suggest alternative routes. The numbers refer to distances over the sea in statute miles.

* * * * *

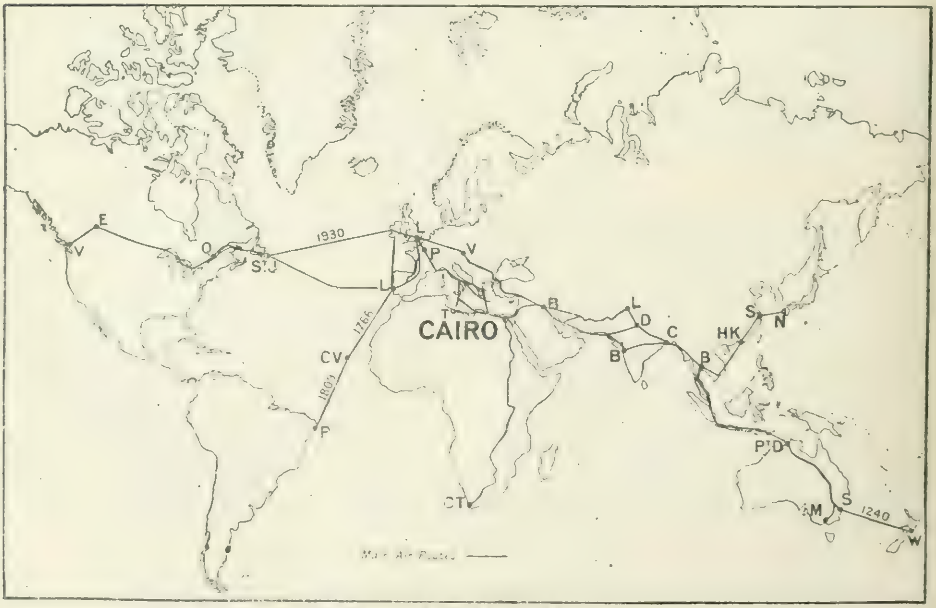
The journey between Egypt and India is very quick by air, and a comparison of the times of transit by sea and air is very interesting. From Cairo to Karachi the journey by air occupies four days, flying by daylight only, while by sea from Port Said to Bombay the journey takes nine days. Between Cairo and Baghdad the journey by air takes twelve hours only; by the existing sea route the time taken is about three weeks. In the second map the air route taken by Ross-Smith is shown, and alternative routes are indicated.

* * * * *

Once in India, there are several ways at the airman's disposal in the trans-Indian journey. From Karachi



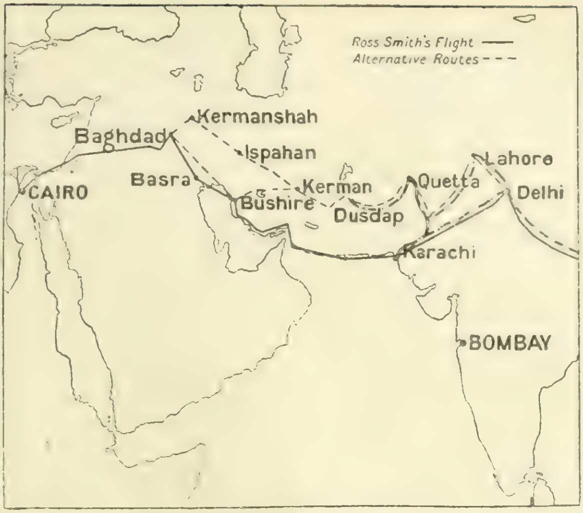
MAP 1.—AIR ROUTES, LONDON TO CAIRO.



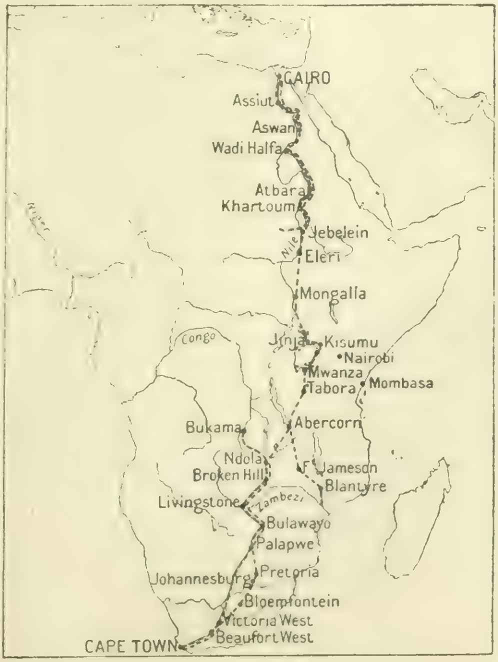
MAP 4.—AIR ROUTES OF THE WORLD.

one may proceed northward to Delhi, and so to Calcutta, through Cawnpore and Allahabad as Ross-Smith did, or via Ahmadabad and Bombay across country to Calcutta through Nagpur. These routes, and also the route from Calcutta to Port Darwin in the North of Australia, are shown in the fourth map.

From Calcutta the route to Australia, as flown by Ross-Smith, is via Rangoon and Bangkok to Singapore, thence to Kalidjati in Java, and via Bima to Atambœa in Dutch Timor. The final stage across the sea to Port Darwin is a distance of 460 miles.



MAP 2.—AIR ROUTE, CAIRO TO KARACHI.



MAP 3.—AIR ROUTE, CAIRO TO CAPE TOWN.

* * *

Of all the aerial routes, the one which probably appeals most to the imagination is that between Cairo and the Cape. This has been recently flown. Along this route, a distance of between five and six thousand miles, there exists a chain of forty-three aerodromes. The route can be best followed by reference to the third map. From Cairo to Eleri in the main the course of the Nile is followed. From Jinga to Mwanza, Lake Victoria is skirted on the eastern shore. A difficult piece of country is encountered between Mwanza and N'dola. From N'dola to Palapwe the route follows roughly the railway, and thence via Pretoria and Bloemfontein it ends at Cape Town.

* * *

The journey from this country to America is likely to be the most difficult of all to accomplish regularly by air. As is well known, the Atlantic has been crossed in a flying-boat via the Azores by Commander Read of the U.S. Navy, by direct flight in an aeroplane by the late Sir John Alcock, and out and back by Major Scott in an airship.

From St. John's, Newfoundland, to Clifden in Ireland is a distance of 1,930 miles, and to Lisbon via the Azores is nearly 2,400 miles, so that getting over is a "tough proposition."

In the fourth map the air routes of the world are shown. The oversea distances are given in miles. The letters are the initial letters of the names of towns, and should suggest the names without difficulty. C.V. stands for Cape Verde Island.

The map embodies, in addition to the routes described, routes which have been suggested for crossing Canada, crossing Australia to New Zealand, and for getting to China and Japan.

The Origin of the Vegetation of the Land

By A. C. Seward, F.R.S.

Master of Downing College and Professor of Botany, Cambridge

Even though we shall never solve many of the problems connected with the early history of the earth, there will always be a fascination in getting the most out of such facts as are available, and drawing upon our imagination for the rest. The origin of life is one of the oldest and most attractive problems that will long continue to exercise speculative minds. A recent contribution to this subject has recently been made by Dr. Church,[1] of Oxford, which deserves careful attention; but it is not with this that we are now primarily concerned. The same author has dealt in a masterly manner with the origin of the vegetation of the land.[2] The hypothesis he elaborates is not only ingenious, but the arguments are logically presented, though in a style which, it must be confessed, is not easy reading even for the specialist. The problem, briefly, is this: What was the origin of the vegetation of the land as distinct from that of the water?

The majority of plants live on land: trees, shrubs, herbaceous flowering plants, Ferns, and Mosses, are either wholly or with comparatively few exceptions dwellers on land. They draw their supply of carbon from carbon dioxide, a gas which forms one of the constituents of the atmosphere; the atmosphere contains about three parts of carbon dioxide in 10,000. The structure of the bodies of the more highly organised plants is intimately connected with the needs of a life on land. The roots take up raw material in solution from the soil; they act as absorbing organs as well as holdfasts; the stem and branches bear the leaves and flowers, or other reproductive organs; some of their tissues are concerned with the conduction of water and with the transport of the organic compounds manufactured in the green leaves to those organs where building-material for new cells is needed. A land plant absorbs water only from the ground, and it must, therefore, be provided with an efficient system of channels for conducting water to all parts of the plant-body. In the higher plants the method of reproduction also is in harmony with land conditions. Thus, some of the essential features of a typical land-plant—for example, a Pine-tree or an Oak—are: (i) that it draws from the soil and the air all the raw material from which it builds up its substance; (ii) that it is able, by means of certain specially strong tissues, to maintain an erect position and to resist the force of the wind; (iii) that it can reproduce its kind without the aid of any reproductive cells endowed with the power of locomotion. A water-plant, on the other hand, is supported by the medium in which it lives. In a seaweed, moreover, which is entirely surrounded by water, absorption is not localised in a special organ, but an efficient water-supply is assured by the permeability of the whole plant, and no special conducting tissue is needed.

In the Ferns, Mosses, and Algæ[3] the act of fertilisation is accomplished, with rare exceptions, by means of free-swimming or floating male cells, and motile or non-motile female cells (eggs). This character is a legacy from ancestors which passed their lives in water, but the higher plants have lost this relic of an aquatic ancestry. Ferns and Mosses, for example (in contrast to aquatic Algæ, which are fully equipped for life in water), may be described as amphibious; though they live for the most part on land and produce spores dispersed by the wind, they are still dependent for fertilisation upon water, as their male reproductive cells swim to the female cells.

We know, from a study of the rocks, that the present vegetation of the land represents merely a stage in a succession of plant-associations which have colonised the earth during millions of years; and we are also in a position to assert that no satisfactory evidence has so far been discovered of the existence of a land-vegetation before a certain period in the history of the earth.

At what stage, then, of geological history did plants first establish themselves on the land? The oldest-known rocks are spoken of by geologists as Archæan: these rocks form a considerable part of the North-West Highlands of Scotland and occur in North and South Wales, in the Malvern Hills, and elsewhere. They consist of granites and other coarsely crystalline rocks of igneous[4] origin, covered in some regions by a great thickness of grit and sandstones formed by the action of denuding agents, rain and frost, and either deposited as sheets of pebble-beds, grit, and sand on the surface of the land, or accumulated as sediments under water. The Archæan rocks reach an enormous thickness, and afford unmistakable evidence that their formation occupied a length of time in the early history of the world which is beyond our comprehension. They give very little information about the kind of life that existed when they were being formed, and there is at least no direct evidence that Archæan lands were tenanted by plants. Resting upon Archæan rocks, and occupying the next place in the succession of geological formations, are thousands of feet of what are called the Cambrian strata, for the most part consisting of material derived from the wear and tear of rocks exposed to the air, which was eventually spread out on the floors of oceans. These Cambrian rocks, with the fossils they contain, tell us much of the animals which lived in the sea, and furnish some evidence of the occurrence of seaweeds. Of a land vegetation they tell us nothing. The next two periods are known as the Ordovician and Silurian. These two chapters of ancient earth-history are represented by vast thicknesses of marine sedimentary strata, and, particularly the Ordovician period, by a considerable development of volcanic lavas and ashes of submarine origin. Much of the most picturesque scenery of the English Lake District is due to mountains composed of volcanic and sedimentary rocks of Ordovician age, originally formed under the sea and then upraised as mountain-chains which, through long exposure to denudation, have lost much of their former grandeur. Both the Ordovician and Silurian rocks, though rich in marine fossils, have hitherto furnished no thoroughly satisfactory records of land-plants.

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[1] *The Building of an Autotrophic Flagellate.* Oxford University Press, 1919.

[2] *Thalassiophyta and the Subaerial Transmigration.* Oxford University Press, 1919.

[3] A large class of plants, most of which live in water; it includes seaweeds, also many simpler types of plants living in fresh-water and on damp surfaces.

[4] Formed by volcanic agency, or from molten material crystallised under great pressure and at a considerable depth below the surface.

Passing to the Devonian period, the next stage of geological history, we find that in some parts of the world marine strata were built up on the floor of the open sea as in the preceding periods, while in other regions material worn by water and frost from the surface of the land was being piled up on the floors of large freshwater lakes and arms of the sea. Rocks of the latter type, usually spoken of as Old Red Sandstone, are a characteristic feature of much of the country encircling the Highlands of Scotland; they occur also in the Shetland Isles, Scandinavia, Ireland, and other parts of the world. It is in Devonian or Old Red Sandstone strata, deposited in lakes or enclosed seas, that representatives of the oldest known land-vegetation have been discovered.

By far the most important samples of this ancient vegetation of the land are the petrified plants, beautifully preserved, with their most delicate cells intact, which were discovered a few years ago by Dr. Mackie, of Elgin, in certain siliceous Devonian beds in Aberdeenshire. Detailed descriptions of some of these fossils have been published in the *Transactions of the Royal Society of Edinburgh*, by Dr. Kidston and Professor Lang (1917, 1920). Many other Devonian plants have been described from different parts of Scotland, from Ireland, Devonshire, Canada, the United States, Norway, Bohemia, Germany, and elsewhere.

It is by no means improbable that plants existed on the land during at least part of the inconceivably long period of earth-history which had passed before the Devonian period began. All that can be said is that the records of pre-Devonian rocks tell us practically nothing of any land-vegetation there may have been. The question now before us is, where were the first land-plants evolved? Were they evolved from simpler forms which originated on an exposed land-surface, or were the earliest land-plants descendants of Algæ living in the sea? Some writers favour the view that plant-life began in freshwater pools on a primeval continent, and it is often assumed that some existing freshwater members of the Algæ, if not themselves the ancestors of the more complex inhabitants of the dry land, at least indicate the lines followed by evolution. Another view is that plant-life began in the sea; Algæ inhabiting the shallow coastal regions migrated, it is thought, through rivers to inland waters and eventually established themselves on the land, thus forming the starting-point of the complex terrestrial plants. Dr. Church suggests a different course of evolution: "The beginnings of Botany are in the sea"; he believes that before continents and oceans divided the world between them, the earth's surface was covered by water; a world-ocean two miles deep wrapped completely round the solid crust. This is, of course, an assumption; and though it is directly opposed to the opinions usually expressed by geologists, the possibility of a complete covering of water is not, so I am informed, beyond the range of possibility from an astronomical point of view. In this original ocean life was evolved—the method of evolution does not now concern us; during a long period the earliest organisms increased in complexity, and at length single-celled plants were produced capable of manufacturing their own food, like the small aquatic green plants of to-day, that build up their substance from salts and carbon dioxide gas absorbed from a watery medium. Thus, the world-ocean, not as yet penetrated by any part of the earth's crust, became tenanted by hosts of unicellular and free-swimming plants. At a later stage, in response to those forces which have been constantly acting on the mass of the earth, portions of the crust rose to within 150 to 100 fathoms of the surface of the ocean and came under the influence of the sun's rays. On this feebly illuminated floor of the shallow sea some of the free-floating plants adopted a sedentary habit, and by slow degrees from unicellular forms were evolved multicellular and more complex seaweeds, which were anchored to the rocks by root-like holdfasts. As time elapsed, these anchored forms developed into larger seaweeds, surpassing, it is believed, both in their structural complexity and in their reproductive mechanisms, even the highest types of existing brown, red, or green marine Algæ. The third stage was inaugurated when domes or ridges of the solid crust of the earth emerged as islands or embryo-continents above the primeval ocean. Anchored submarine plants found themselves transferred from water to air: for a time they would be washed at intervals by the waves, but as elevation continued they became more and more restricted to an environment of air containing an abundant supply of aqueous vapour. This change naturally imposed serious problems upon organisms adapted to a purely watery habitat. The better-equipped types, Dr. Church suggests, successfully coped with the new conditions; their anchoring holdfasts acquired the function of absorbing organs; and the water with mineral salts in solution, which they imbibed, had to be conveyed by newly developed conducting tissues to all parts of the plant-body, which was now no longer bathed by water. Adjustment was necessitated in the mechanism for propagation; reproductive cells capable of dispersal in the air were substituted for cells adapted for locomotion or transport in water. Thus was effected a transformation of complex seaweeds into land-plants, and it was this direct passage from sea to air that gave birth to the future vegetation of continents and islands. If this hypothesis is correct, it means, as its author points out, that all the groups of land-plants trace their ancestry to a stage in the history of the world when a world-ocean was inhabited by swarms of free-floating, single-celled representatives of the plant kingdom.

Dr. Church is of opinion that the uplift of portions of the earth's crust, with their attached seaweeds, occurred in the Archæan era, in the earliest stage of geological history. If this was so, it is surprising that no fossil remains of this first land vegetation have been found; and it may well be that the first stage in the evolution of a land-vegetation—assuming the general correctness of the hypothesis that has been outlined—occurred at a later period in the history of the earth. It is a well-established fact that in some parts of the world, mostly in the north-west European area, there was a great uplift of the earth's crust in the Silurian, and during the earlier phase of the Devonian periods. This widespread folding of the crust produced vast mountain systems, called by the late Professor Suess the Caledonides, and the worn-down roots of some of these ranges form the present mountains of the north-west Highlands of Scotland. As we have seen, it is in the Devonian rocks that the earliest undoubted land floras have been discovered. Whether or not the successful transference of seaweeds to life on the land occurred in the Archæan or in a subsequent period, the interest of Dr. Church's attractive and ably worked-out hypothesis lies in the possibility of the adaptation of organs, which had been evolved in the sea, to the very different conditions of life on land. The views he expresses, though open to criticism on geological and biological grounds, are worthy of close examination; they are concerned with a problem that is perhaps insoluble, but they are at least suggestive, and in many respects more convincing than any previously put forward.

St. Francis of Assisi (A.D. 1182-1226)

By A. G. Little, M.A.

"WHY after thee?" asked one of his companions of St. Francis. "Why doth all the world follow after thee, and why doth every man desire to see thee and to hear thee and to obey thee? Thou art not fair to look upon; thou art not a man of great parts; thou art not of noble birth. Whence cometh it, then, that all the world followeth after thee?" St. Francis's "lowly answer" that God had chosen him to confound the might and wisdom of the world, "because He hath found no viler creature on earth," can hardly have seemed a complete explanation to Brother Masseo, nor can it satisfy us. The interest shown in St. Francis is different, not only in degree but in kind, from the interest taken in any other mediæval saint; it is not only erudite or devotional, though it is both of these; but men of very different faiths have studied, and are studying, the life of St. Francis with the conviction that it contains some practical message for all time and for to-day.

The hold which St. Francis always had on the affection of the world is no doubt partly due to the large amount and to the nature of the literary material concerning him which has survived from early times. No saint is so well known. The charming and poetical stories known as the *Fioretti*, or *Little Flowers of St. Francis*, have rejoiced generation after generation ever since they were collected together and translated into Italian early in the fourteenth century. There are excellent English translations of the *Fioretti*, such as that by Professor Arnold and that by Professor Okey; but they are easy to read in the original, and form an attractive introduction to the study of Italian. The collection does not include, by any means, all the stories which were current at the time when it was made, and several which might well have been included have recently come to light. One of these tells how Francis and his first follower, Bernardo, being tired and hungry, went to beg for food, agreeing to meet at a certain stone. Francis came back with his scraps, but Bernardo confessed with shame that he was so hungry that he had eaten all the crusts given to him. Francis shed tears of joy (or laughed till he cried), and said: "Thou art more blessed than I, dear son; thou art truly a perfect observer of the Gospel; for thou hast gathered nothing and kept nothing for the morrow, but hast cast thy whole thought upon the Lord."

The number of books on St. Francis which have come out in the last thirty or forty years is enormous, and is still growing. It is something more than a literary fashion. It is noteworthy that the first impetus to Franciscan studies proceeded, not from Catholic but from Protestant circles, and a certain amount of religious controversy has been mixed up with the history. It is easy to see what attracted Protestant theologians and historians to St. Francis: it was his attempt to go back directly to the Gospels for inspiration, and to reproduce again on earth the life of Christ and His Apostles. He habitually claimed immediate revelation from God as his authority. "After the Lord had given me the care of brethren, no one showed me what I should do, but the Most High revealed to me that I should live according to the pattern of the Holy Gospel." One can hear in this sentence from the Testament of St. Francis an echo of the perennial conflict between prophet and priest; but some of his recent biographers have overemphasised the differences between the saint and the Papacy, and have even suggested that he was not a loyal and submissive son of the Roman Church. The charge has been brought against Paul Sabatier—not without a certain measure of justification—that his famous *Vie de Saint François* represents the poor man of Assisi as a precursor of the Reformation. Sabatier's profound researches into Franciscan history since he wrote the *Life* have materially modified his original views, and we may look for considerable changes in the revised *Vie de Saint François* which he has prepared; but his original views were far nearer the truth than those which make St. Francis a passive instrument in the hands of the Roman hierarchy.

Few have reconciled more completely than St. Francis submission with liberty. His attitude to the Church may be compared with that of a loyal subject to the State. The loyal subject recognises the authority of the State; but that does not prevent him from endeavouring to change and reform the State, and bring its policy into harmony with his own ideas. A point may come when one has to choose between rebellion and submission either to Church or State; this point was reached by some of St. Francis's followers a century later, when they renounced allegiance to the "carnal Church" and tried to establish a spiritual Church. It is safe to say that the idea of rebellion never even occurred to St. Francis. He was saved from this partly by the wisdom of the rulers of the Church, but mainly by his own character and power.

Pope Innocent III was an autocrat, but he did not claim a monopoly of initiative, and was willing to admit that a simple layman might have surer instincts, might be more truly inspired by God, than a Pope. Francis asked his approval for the way of life which he had already chosen for himself and his followers. "Pray God, my son," the Pope replied, according to one account, "that He reveal unto thee whether what ye seek cometh of His Will, so that we, being assured of the Lord's Will, may accede unto thy desire." "Go," he said finally, "and the Lord be with you, brethren, and as He shall deign to inspire you, preach repentance to all."

There is plenty of evidence of the extraordinary power exercised by Francis over all classes of people. He radiated peace, goodwill, and confidence. It was not what he said, but his personality, that affected them. A learned philosopher remarked that, while he could remember every word of the sermons of others, "the words uttered by holy Francis alone escape me; and if I commit any of them to memory, they do not seem to me the same that dropped from his lips before." Another description of his preaching—by the Archdeacon of Spalato—runs as follows: "In 1222, on the day of the Assumption (August 15), when I was a student at Bologna, I saw St. Francis preaching in the piazza in front of the public palazzo. Almost all the city had assembled there. His text was 'Angels, men, devils,' and he discoursed of these three rational spirits so well and wisely that many learned men who were present were not a little amazed at the words of such an ignorant man. Yet his style was not that of a preacher, but of a man conversing. The whole matter of his discourse was an appeal to extinguish enmities and to make lasting peace. His dress was mean, his appearance contemptible, and his face without beauty; but God lent such power to his words that many bands of nobles, among whom the savage fury of ancient feuds had raged with much shedding of blood, were brought back to the way of peace. Such was the reverence and devotion which he inspired that men and women rushed to him in crowds, happy if they could touch the hem of his garment or carry off some bit of his habit."

A peacemaker had no lack of opportunity in thirteenth-century Italy. Feuds between families, between cities, between classes, between parties, between ecclesiastical and civil authorities, were everywhere prevalent, and every success involved reprisals and every act of violence intensified hatred. When Francis lay dying, a great quarrel arose between the

Bishop and the chief magistrate of Assisi: the Bishop excommunicated the magistrate and the magistrate boycotted the Bishop. Francis, hearing of it, added another verse to his "Praises of the Creatures" or "Song of Brother Sun": "Praised be Thou, O my Lord, of them that forgive for love of Thee," and told his companions to get the two enemies together and sing it to them; whereupon Bishop and magistrate both confessed themselves in the wrong, asked forgiveness, and fell into each other's arms. Francis made no attempt to go into the merits of the case; he simply substituted an atmosphere of love and mutual trust for one of hatred and suspicion. He attached much importance to the power of music and singing, and wished that his brethren after preaching should sing the praises of the Lord, and that when the song was ended the preachers should say to the people: "We are the minstrels of the Lord, and the pay that we ask of you is that you should be in a state of true repentance." For he would say: "What are the servants of the Lord but His minstrels, who lift up the hearts of men and move them to spiritual gladness?"

If we ask what was the secret of his power, there is no adequate answer; but it may be found partly in three qualities which he possessed in a pre-eminent degree—sincerity, sympathy, and selflessness.

If he was ever actuated by "mixed motives," he at once made public confession, "that he might not appear outwardly other than he was inwardly." "Once, when he was walking through Assisi, he met an old woman who asked him to give her something. Having nothing but a cloak, with ready bounty he gave her that. But perceiving an impulse of self-complacency stealing over him, he immediately confessed before all the bystanders that he had been moved by vainglory."

Many instances are recorded of his power of divining the unspoken thoughts and feelings of others, which to his biographers appeared miraculous. "Saintlier than saints," says his earliest biographer, "among sinners he was as one of themselves." He never felt himself superior to anybody, and one product of his humility and sympathy was a natural courtesy to all sorts and conditions. "Courtesy," he said, "is an attribute of God Himself, who makes His sun to shine and His rain to fall equally upon the just and upon the unjust: and courtesy is the sister of charity, and quenches hates and keeps love alive."

His sympathy extended to all nature. He regarded the sun and fire as brothers, the birds and flowers as sisters:

> Communing in this sort through earth and heaven
> With every form of creature, as it looked
> Towards the Uncreated with a countenance
> Of adoration, with an eye of love.

Francis craved nothing for himself and his followers except the right to possess nothing—the "privilege of poverty." The friars differed from the monks in this among other things, that their vow of poverty involved the renunciation not only of private but also of corporate property. But renunciation of property is a poor way of expressing St. Francis's enthusiastic devotion to Holy Poverty—"that celestial virtue by which all impediments are lifted away from the soul, so that she can freely unite herself to the eternal God." We are accustomed to think of a poor man as one who lacks the advantages of riches: St. Francis thought of a rich man as one who lacked the inestimable boon of poverty. He served the "Lady Poverty" as a knight in the romances of chivalry served his ideal lady. Such service must be free. Francis had no desire to deprive other people of their property; he set an example, which others might follow, but the sacrifice must be willing.

His attitude is hard for us to understand; it was also hard for his contemporaries, and in defending his ideas to the magnates of the Church he used less exalted and more comprehensible arguments. "If we should have possessions, we should need arms to protect ourselves. For thence arise disputes and lawsuits, and for this cause the love of God and our neighbour is wont often to be hindered, wherefore we are minded to possess naught of worldly goods in this world."

The early friars lived by the labour of their hands and by alms. "I worked with my hands," said St. Francis in his last Testament, "and I wish to work, and I wish firmly that all the other brothers should work at some labour which is compatible with honesty. . . . And when the price of labour is not given to us, let us have recourse to the table of the Lord, begging alms from door to door." In course of time, as the friars' work became more and more that of preachers and teachers, manual labour was confined to the work of house and garden (there is a story that, when the Pope's envoys brought the Cardinal's hat to Bonaventura, he was washing up the dishes, and asked them to hang it up outside), and the friaries depended, like many churches, schools, and hospitals to-day, on voluntary contributions.

The rapid increase and spread of the Order necessitated a more elaborate organisation and rules for the enforcement of discipline. The reign of love had to yield to the coarser reign of law. Francis was not an organiser, and was more alive to the evils than to the advantages of organisation. The exercise of authority by one man over others was repugnant to his nature. Those in authority should be ministers and servants; and erring friars, when they go to them, "may speak and act with them as masters with their servants." That is in the Rule. A topsy-turvy world, but it must be remembered that Francis aimed at putting into practice the precepts of the Gospel. The task of reconciling the ideal with the real was beyond him. He had always taught his followers that they must convert by humility and reverence, and so now, when they demanded other methods, he "would not become an executioner to punish and scourge them, like the magistrates of this world," but retired more and more from the management of affairs; he tried to fulfil his ideal in his own life, and be an example, or "Mirror of Perfection," to the brethren, "and at the end his spirit did herein find rest and comfort."

tanto elenato daterra chelli nol

BROTHER LEO KNEELING BEFORE ST. FRANCIS.
From the *Little Flowers of St. Francis* (T. W. Arnold), by kind permission of Messrs. Chatto and Windus.

One among the many services rendered to Franciscan history by Sabatier is his rediscovery and rehabilitation of the *Speculum Perfectionis*, or "Mirror of Perfection,"[1] but few will now admit his contention that the original version of it was written by Leo, the secretary of St. Francis, in 1227, and was consequently the earliest *Life* of the saint. The view which is now held by most Franciscan scholars is that the *Mirror of Perfection* dates in its present form from about 1318, but that it contains, in a more or less revised shape, many chapters and narratives written by Brother Leo, and perhaps by other companions of St. Francis. The aim is to distinguish between genuine and spurious, or garbled, versions of the narratives, and if possible to recover the originals.

St. Francis died on October 3, 1226, and the earliest *Life* of him is that written by Thomas of Celano[2] in 1228–9. Celano was selected for the office of biographer because he was a stylist; his work has many merits, but suffers from two defects: the writer had very little personal acquaintance with Francis; and he knew too much about the lives and legends of other saints. There is thus a certain tendency—conscious or unconscious—to assimilate Francis to the traditional and conventional saint.

When, in 1244, it was decided to revise and supplement the first *Life*, the task was again given to Celano, but with him were associated the friars who had been the companions of St. Francis in his last years (especially Brother Leo), and they supplied most of the new matter which Celano worked up into literary form in the second *Life*. Some of the contributions made by the companions are incorporated in the *Speculum Perfectionis*, and a few more have recently been found.

One example may be given. Celano, in the second *Life*, tells how Francis one night in his last illness longed for a little parsley, and of the difficulty he had in persuading the Brother Cook to go out and hunt for it on a dark, windy night. When at length the parsley was found, Francis improved the occasion by saying: "My brethren, obey orders at once, and do not wait for them to be repeated; and do not allege that anything is impossible, for even were I to bid you to do anything beyond your strength, obedience would not be wanting in strength." That is what a saint ought to have said. A primitive version—probably a copy of the original supplied by Leo—of the narrative was discovered in a manuscript a few years ago. The story of the parsley is given in simpler language than Celano's and far more vividly, and St. Francis's words are: "My brethren, you should not make me say a thing so often" (*Fratres mei, non*

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[1] *Speculum Perfectionis seu S. Francisci Assisiensis Legenda Antiquissima.* Ed. P. Sabatier, Paris, 1898. Translated by Evans (Nutt), Okey (Dent), etc.

[2] Both the *Lives* by Thomas de Celano were edited by E. d'Alençon, Rome, 1906: translation by Ferrers Howell, Methuen, 1908.

debetis me facere dicere rem totiens)—not what a saint ought to say, but the weary protest of a sick man.

Other examples are contained in the same manuscript,[1] and more discoveries of the same kind must be awaiting the careful and lucky researcher. Each point by itself is small: the cumulative effect is considerable, and the more we can recover of the actual written words of those who knew St. Francis best, the more vivid, the more human, and the more true, our conception of him will become.

NOTE.—References to the literature on the subject will be found in the writer's *Guide to Franciscan Studies*, S.P.C.K., 1920.

Flying—and Its Outlook from a Postal Telegraph Point of View

By A. S. Baxendale, M.I.E.E.

MUCH has been said and written about Commercial Aviation, but except for valuable contributions from Mr. Holt Thomas, particularly regarding costs ascertained by more or less bitter experience, I have heard or read little on this subject that has not conveyed to my mind the impression that the speakers and writers have only vague notions as to the possible directions in which aviation can render real benefit to the public.

The importance of concentration along lines of least resistance, combined with a just value of the objectives in view, will be recognised by those who have seen how disastrously some inventions and enterprises of immense potentialities have been retarded in their development because their progenitors have from their angle of view seen only some small side-track instead of the main-line along which progress should have been made. In other cases it would seem that the protagonists have fallen in with the view of those of their financial friends who consider that the best use to which anything can be put is to convert it into a gambling counter.

Perhaps the views of one who has spent more than twenty years in organising and controlling postal and telegraph services will serve to give a practical turn to the consideration of some of the more important points involved in the development of air transport.

In aerial as in all other forms of transport the first consideration is that of reliability, and, unlike other forms of transport, reliability in the air depends largely on speed. At a safe cruising height—an altitude, say, of 4,000 to 5,000 feet—a gale of 80 knots often prevails, and a comparatively slow machine facing this gale is more or less in the same predicament as a slow steamer endeavouring to go upstream in a river having a current of, say, 15 knots.

Next to regularity, the most important consideration is frequency of service, and if it were not for the fact that regularity depends on speed,[2] speed would be much less important than frequency of service.

With equal reliability two services a day at an average of 70 miles an hour would be much more useful than one of upwards of 100 miles an hour.

The service now being operated between London and Paris, which, though scheduled and under contract with the Post Office to ply daily, must still be considered in the light of an experiment, affords a good example of the futility of operating a single dispatch service.

It will be seen from the following table that, for nearly every hour of the day when letters are generally posted, the length of time elapsing between the posting and delivery of correspondence (called technically "the delay") is considerably greater in the case of air transport than by the ordinary postal services by means of rail and steamship.

Letters posted in London at	Should be delivered in Paris by air	Should be delivered in Paris by post
10 a.m. . .	6 hours later[3]	22 hours later[4]
11 a.m. . .	5 ,, ,,	21 ,, ,,
Noon . .	28 ,, ,,	20 ,, ,,
1 p.m. . .	27 ,, ,,	19 ,, ,,
2 p.m. . .	26 ,, ,,	18 ,, ,,
3 p.m. . .	25 ,, ,,	17 ,, ,,
4 p.m. . .	24 ,, ,,	16 ,, ,,
5 p.m. . .	23 ,, ,,	15 ,, ,,
6 p.m. . .	22 ,, ,,	14 ,, ,,
7 p.m. . .	21 ,, ,,	13 ,, ,,
8 p.m. . .	20 ,, ,,	36 ,, ,,

By an air service of 70 miles an hour—assuming such to be maintainable—with two machines starting daily each way respectively at 7 a.m. and 4 p.m., the average delay would be reduced to 13 hours 19 minutes, as against an average of 22 hours 31 minutes by the fast machine performing only one service a day, and an average by the ordinary postal service of 19 hours 12 minutes. A further increase in the frequency of service from one to, say, twelve dispatches a day would render the air mail not only in all cases much more rapid than the ordinary postal service, but generally speaking more rapid than telegraphy, even should the normal telegraph service be more or less restored.

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[1] Described in *Collectanea Franciscana I* (British Society of Franciscan Studies, vol. v).

[2] Speed has its disadvantages from the point of view of requiring greater space for landing and rising. The fast machine that will land like the proverbial poached egg has not yet been built, and many of the fast types land at a speed of fifty to sixty miles an hour. In spite of this fact, however, it must be taken that for regularity of service high speed is essential.

[3] Leave Hounslow 12.30, delivered Paris 4 p.m.

[4] Leave London by night mail, delivered in Paris 8 a.m.

The question now arises as to the cost and difficulty of greatly increasing the frequency of air services. It is in this respect that the true fundamental advantage of air transport for the rapid delivery of passengers and correspondence at their destination is most easily demonstrable.

The load required to make a trip between London and Paris reasonably remunerative, assuming the service is frequent and the cost of the machines in use does not exceed on the average £1,000, is one passenger, 100 letters, and 150 lb. of goods at the prices now charged. If it were found difficult to secure even this small load at present prices, the rates could be lowered to some such figure as £5 for passengers, 3*d.* for letters, 1*s.* for aerograms of any length (in addition, of course, to local telegram rates), and 1*s.* a lb. for goods. An average load of two passengers, 500 letters, 100 telegrams, and 200 lb. of goods would then be sufficient to render the service self-supporting.

Having been closely concerned in fixing the aerial letter-rate between Paris and London at the charge of 2*s.* 6*d.*, I feel it necessary here to explain how this tariff, which I consider much too high in the present circumstances, came to be chosen.

At a formal interview I had with M. Clementel (Minister of Commerce) and M. Pasquet (then head of the permanent staff of the Postal Telegraph Department) regarding the establishment of an aerial mail service between France and England in 1917—when the ordinary postal service was occasionally discontinued for days together—I was asked what rate I would propose should be charged. I pointed out that the rate would have to be one that would limit the use of the service to senders of letters of real importance, for not only had we but little spare carrying capacity in the machines which it was proposed to employ, but in view of the strict censoring that took place at that time, we wished to reduce the mail to such proportions as would enable the censors at the aerodrome to deal without excessive delay with the whole mail; and I suggested three francs as a charge that would restrict the public use of this service to such an extent as to keep the air mail within the required limits. MM. Clementel and Pasquet accepted this figure. When the present service was commenced and it was desired that it should be utilised by as wide a public as possible, I was naturally surprised to see the charge fixed at a figure which I had suggested would be generally considered prohibitive.

I am inclined to think that double the registered express postage rate would be about as high a rate as should be charged.

As regards the load of telegrams that I anticipate will be carried, I will take this opportunity of recording my considered opinion that the first of the great public services to feel the competition of aerial transport will be cable companies.

In order to realise the limitations of telegraphy, it is necessary to appreciate the folly of a remark attributed to one whose leading characteristic is not generally believed to be lack of intelligence. The remark was to the effect that " aerial transport will never compete with wireless telegraphy until the plane travels at the same speed as the wireless wave," viz. 180,000 miles a second. The rate of travel of electricity is about as closely related to the speed of telegraphy as the speed at which sound travels is to the performance of any given stenographer. It may interest the layman to know that, had all the trans-Atlantic cables been interrupted for a week prior to Sir John Alcock's flight, and had he carried one half of the accumulated cable traffic, while the other half had to be dealt with by wireless, Sir John Alcock's half would have been delivered as expeditiously as it is now ordinarily carried by cable, whereas the wireless half would have been " cleared " at about the time of the death of the great pilot.

In these days, when labour-saving has become a matter of paramount importance, it seems to me impossible to doubt that the greater number of international messages which would now be dealt with solely as telegrams will in the not very distant future be dealt with in the countries of origin and destination telegraphically or telephonically, while they will become aerograms so far as international transport is concerned.

It must be remembered that any ordinary commercial aeroplane can convey as many telegrams as thousands of operators can handle—and there are many international aerial services which might be established even to-day where the delay on aerograms would be anything from one-half to one-twentieth of that now occurring on telegrams.

When, if ever, what we consider normal telegraph services are in operation, they will generally afford a quicker means of communication than will aerial transport, but it has now been amply demonstrated that those who held the view that the majority of cablers require speed without regard to cost were entirely mistaken.

It was more than twenty years ago that I established the "deferred" telegram system (at half the "ordinary" rates) in the Federated Malay States. I was not, therefore, misled by the arguments of theorists when, as Manager of the Pacific Cable Board (which led the way in the world-wide adoption of deferred cable rates), I was informed by most of my old cable friends that we were catering for a public that did not exist.

As a matter of fact, I believe I am correct in saying that in 1913, 75 per cent. of all cable traffic was sent at deferred rates. What I consider to be really a striking fact is that in the first half of 1914 the latter development of the "week-end cable letters" (at quarter rates) was fast becoming so popular that they already amounted to quite a considerable proportion of all the traffic. In view of these facts, no doubt can exist in the mind of any reasonable person that there is a very large public ready at any time to take advantage of any means of communication which is considerably more rapid than the Postal Service, and willing to pay for such communications at rates calculated on a word basis.

Whether the operation of such services will be remunerative depends on their treatment by the Government. So far the authorities have failed to give even the assistance they might have given without cost to the public funds. The grant of machines without charge to companies performing public services would have enabled the contractors to fix rates independent of depreciation, and these rates would have been substantially lower than those which are possible when depreciation (still an unknown quantity in commercial aviation) has to be provided for.

Having sold the spare machines in their possession —to a private company at a nominal price—it would seem that, if the Government proposed to give assistance to the commercial air services, this assistance must now take the form of a subsidy, or the equivalent of a subsidy, such as guaranteed remunerative loads. Unless some form of State aid is given, the United Kingdom is likely to lag behind in air transport. If my view is correct that the essentially British enterprise of submarine cable telegraphy will in the course of some few years be engaged in a life-and-death struggle with aerial transport, this kingdom will indeed be hard hit should this latter means of communication then be under foreign control—and in receipt of heavy subsidies.

Messrs. Longmans hope to have ready early this month *The Life and Work of Sir Jagadis C. Bose*, founder of the Bose Research Institute, Calcutta, by Professor Patrick Geddes, of the Department of Sociology and Civics, Bombay University. The memoir, which includes numerous illustrations, shows Bose, the first Indian of modern times who has done distinguished work in science, not simply as a physicist of fine experimental skill, but also as a naturalist of the keenest interest in life-processes and life-movements.

Correspondence

To the Editor of DISCOVERY

SIR,

Allow me a brief note on Professor Calder's interesting article in the April issue on "The Date of the Nativity." The argument is on the whole impressive, but there is adduced a parallel from Scottish History which, not being a real parallel, rather weakens it.

On p. 102, column 2, about the middle, Professor Calder says: "Quirinius's engineers could no more have constructed this elaborate system of roads—one of them through the very heart of the Homanadensian country—before the complete subjugation of the mountain tribes than General Wade could have built his fortresses and roads in the Scottish Highlands before Culloden."

Unfortunately for the analogy, General Wade constructed his wonderful roads and bridges not after, but *with a view to*, the complete subjugation of the Highlands. In consequence of the disorders which prevailed before and after the Jacobite Rising of 1715, the Government sent Wade in 1724 to report on the situation. When he returned about two years later as Commander-in-Chief of the royal forces, he set about his great task of opening up the Highlands by a road system which would provide communication alike for warlike and for peaceful purposes. He was able to do much in the way of pacifying the clans, but still many Highlanders cherished their loyalty to the exiled dynasty, and the landing of Prince Charlie in 1745 set the heather on fire.

Wade retired from the command on the appointment of the Duke of Cumberland, who defeated the "Rebels" at Culloden on April 16, 1746.

The sequence of things is therefore just the opposite of what Professor Calder represents.

CAMPBELL M. MACLEROY.

13 WESTBOURNE GARDENS,
GLASGOW.
April 22, 1920.

PROFESSOR HEARNSHAW AND NAPOLEON

To the Editor of DISCOVERY

SIR,

I have read with great interest the article of Professor Hearnshaw in DISCOVERY for April 1920, but there are some things to which, as an historian, I cannot give my adhesion. I will confine myself to two expressions only, the "escape" of Napoleon from Elba on p. 106, and "Napoleon in his mad adventure of 1815," on p. 107. The word "escape" implies that Napoleon was imprisoned at Elba, or at least interned. This is quite contrary to the facts, and was indignantly disclaimed by Castlereagh in Parliament. He said that Napoleon was not in any way to be considered as a prisoner in Elba, as the sovereignty of the island had been conferred upon him, and to look upon him in any other light would be a contravention of the Treaty. The "mad adventure" requires more consideration. I shall endeavour to show that it was impossible for Napoleon to remain in Elba, that his march to Paris was one of the most heroic exploits in History, that its conception and execution was a work of consummate genius, that no more emphatic plebiscite was ever given by a nation to the sovereign of its choice, that England, and indeed Europe, had no right to interfere with the decision of the French people, and to impose upon them a dynasty which they detested.

Napoleon had many reasons for leaving Elba. He had no money. Of the annual revenue of two millions of francs from the Grand Livre of France, promised to him and to his wife in reversion by the Treaty of Fontainebleau, not a sou had been paid. The excuse of Castlereagh, that the pension, being an annual one, did not become due till the year had expired, was treated with contempt by Lord Wellesley, and Lord Grey denounced the "low and pitiful expedient of arguing that the Treaty of Fontainebleau had not been violated because the money stipulated did not become due till the end of the year." Talleyrand was endeavouring to persuade his friends in Vienna that the residence of Napoleon at Elba was a danger to France, and that he should be removed by force or fraud to some other place. St. Helena was mentioned, but was considered to be too healthy. But, worse than this, at the very time when Talleyrand was getting his colleagues to sign the Declaration of March 13, one of the most disgraceful documents in the archives of History, he and Fouché were plotting to assassinate the Emperor in his island, to make the "Aiglon" Emperor, with Marie Louise as Regent, and of course themselves as rulers of France. Wellington, an honourable man, put his name to this document, having only just arrived at Vienna, and having not yet discovered with what a scoundrel he had to deal. The Declaration was very properly denounced in Parliament by the Opposition, which, although small in numbers, was more weighty in intellectual and moral force than the Government, and had as leaders the men who afterwards made the beneficent and peaceful revolution of 1832.

What was this "mad adventure"? Napoleon landed at Golfe Juan on March 1, 1815, with 1,100 men and no horses, and entered the Tuileries as a sovereign at 9 p.m. on March 20, without having fired a shot. The most remarkable incident of his progress took place on March 7 at Laffrey. On the narrow road between the lake and the hills a battalion of infantry was drawn up, commanded by Delessart, a boy of nineteen. He said to an officer of Napoleon's, "I am determined to do my duty, and if you do not immediately withdraw I will have you arrested." "Will you fire?" said the officer. "I will do my duty," replied the boy. Napoleon ordered his soldiers to carry their muskets under their left arms and advanced alone. A captain gave the order, "There he is, fire!" The soldiers were livid, their limbs shook and their hands trembled. Advancing within pistol-shot Napoleon opened his overcoat, and said: "If there is amongst you a man who wishes to kill his Emperor, he can do it; here I am." A great shout rose of "Vive l'Empereur!" the ranks were broken, white cockades strewed the ground, and shakos were raised on the bayonets. The soldiers rushed to the Emperor, surrounded him, cheered him, knelt down before him, stroked his boots, his sword, and the hem of his garment. Delessart broke into tears and tendered his sword to the Emperor, who embraced and comforted him. Surely this is one of the great scenes of History!

The debates in both Houses of the English Parliament should be read by every Englishman at the present time. Burdett argued that the Government had no right to impose a sovereign on an independent nation against its will; whoever heard of a single man invading a nation of thirty millions and becoming sovereign against their will? The nation worked for him, greatly from dislike of the dynasty which he overthrew. England had done enough for the Bourbons; they had cost the country eight hundred millions of money and oceans of blood. Napoleon Bonaparte was Emperor of France by the wish of the French people. In his march of five hundred miles there was not a single individual to lift up his hand against him: how could the feeling of the people be more unequivocally shown? Whitbread, perhaps the noblest character in the House, said that the restoration of Bonaparte to the throne of France was even more miraculous than his original elevation to it. Sheridan denounced the manifesto of March 13, and moved an amendment in favour of peace, which was supported by Lord Althorp and Tierney. This is what the best statesmen in England thought of what Professor Hearnshaw calls a "mad adventure." Most Englishmen, acting on the universally accepted principles of the present day, would consider that we had no right to undertake the Waterloo campaign, and some might come to the conclusion that it would have been better for the world, and possibly for ourselves, if Napoleon had won the Battle of Waterloo.

OSCAR BROWNING.

ROME.

To the Editor of Discovery

Sir,

I feel much honoured that the venerable Mr. Oscar Browning, in his distant home, should have thought it worth while to read my article in Discovery on the "Concert of Europe," and I am delighted that it should have called forth from him so vigorous and interesting a letter, even though he writes in criticism of two of my remarks.

The remarks to which he takes exception are fortunately purely incidental; they do not in the smallest degree concern the main thesis of my article. First, he objects to my speaking of Napoleon's "escape" from Elba, on the ground that it implies imprisonment. Secondly, he protests against my calling the Hundred Days a "mad adventure," on the ground that Napoleon was within his rights in undertaking it, and that the French were justified in supporting him.

The first is a mere question of terminology. It is true that, owing to the insistence of Alexander I, a pretence was made that Napoleon was free in Elba, that he was a sovereign potentate, and that he had simply exchanged one realm for another. But it was a transparent fiction. Napoleon was no more free than Elba was an empire. Dr. Emil Reich is not far wrong when he bluntly calls Napoleon "a prisoner." English and other ships patrolled the seas round the island, and kept constant watch. Napoleon, in order to get away, had to elude these vigilant vessels, and therefore his departure from Elba was, in the strictest sense of the term, an "escape."

As to the "mad adventure" of the Hundred Days: here we are in the doubtful regions of conflicting opinion. Mr. Browning maintains that it was a *legitimate* adventure. It might very well have been legitimate and yet at the same time mad, because doomed to certain failure. It would be a sufficient defence of my phrase to show that, even apart from the antagonism of Europe, Napoleon had not a chance of permanent success. The "Liberal Empire" which he proclaimed on his landing in France was no more possible in 1815 than it was when his nephew proclaimed it half a century later. Mr. Browning, however, does not discuss the problem from the point of view of possibility or prudence. He treats it as a question of legitimacy or right. That is an entirely different matter, and one with which I did not profess to deal, either directly or indirectly, in my article. If, however, I were called upon to discuss it, I should be prepared to contend: (1) That the supporters of Napoleon, who had been imposing upon half the peoples of Europe "dynasties which they detested" during the whole of the preceding decade, had little cause for complaint if they were called upon to endure the fate which they had freely inflicted; (2) that the Concert of Europe, or the League of Nations, may be occasionally compelled to do things which offend the sensibilities of individual nations, and that on this occasion the peril of leaving Napoleon at the head of great armies in France was one which, in the interests of Europe, it was impossible to allow.

F. J. C. Hearnshaw.

King's College,
London.
May 1, 1920.

The Discoveries in Crete

By George Glasgow, B.A.

[It is impossible to allow these pages to go to press without indicating, no matter how inadequately, the part played by Ronald Montagu Burrows, who died on May 14, in the establishment of the facts which are here recorded. Since 1900 the avalanche of new discoveries in Crete had been so overwhelming, so revolutionary to all former conceptions of Greek and European history, that scholars and general public alike were left wondering and at sea. In 1907 Burrows published his *Discoveries in Crete* (Murray), and by his complete mastery of the enormous material available, his lucid exposition of it, his brilliant interpretation, which in many cases involved fundamental contributions to knowledge, he provided what was indispensably needed. A second edition was called for in a few months. The book stands as the classic authority on the subject, and links its author's name with that of Sir Arthur Evans for all time in the work of establishing the existence of a whole civilisation which existed in the Mediterranean 4,000 years ago.

Ronald Burrows should not have died so young. At 52 he was producing work in the very ecstasy of his form. He was incredibly, almost challengingly young, and vigorous in his appearance and in his activity, yet mature in quality and achievements. We shall never see all the final touches he was engaged in adding to still another revised edition of *The Discoveries in Crete*; yet incomplete as they are—I have had the privilege of seeing them in manuscript—they will when published raise the book to a still higher plane. There is no need to dwell on Burrows' own excavations at Pylos and Sphacteria and at Rhitsona. They are known to all scholars as the brilliant work of a brave and resourceful discoverer, who never knew when he was beaten and never failed to get to the bottom of formidable difficulties. His great knowledge, clear and unerring perspective, and the infinite care with which he used them, should have been spared to us for many years hereafter.

The following articles are but one feeble manifestation of what I and thousands of others have learned from Burrows. I wish I could make a truer tribute to my great friend and teacher.]

I

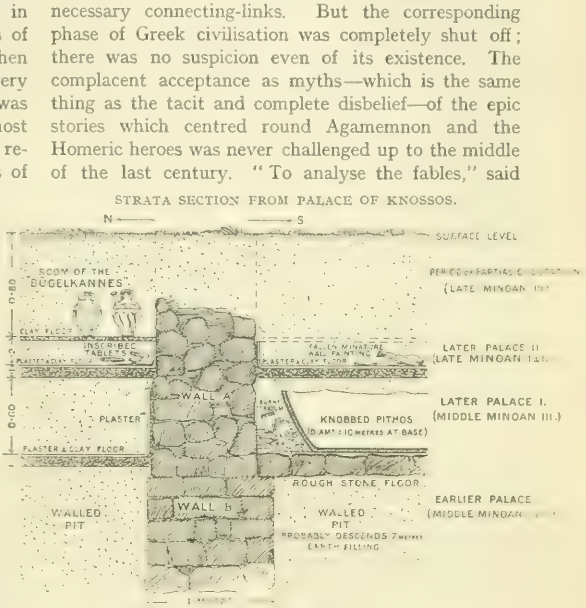
The Greek Premier, Mr. Venizelos, one of the few great statesmen in Europe to-day, comes from Crete. This fact seems to clinch in a striking way a connection which began four thousand years ago. It was in Crete, at that remote period, that the foundations of Greek and indeed European culture were laid. When Mr. Venizelos was a boy, this fact, as that of the very existence of a prehistoric Cretan civilisation, was unknown. Our knowledge of it has been almost entirely acquired since 1900. In this short time remarkable revelations have been effected by means of the spade, mostly by the spades of Sir Arthur Evans. Excavation at Knossos, Phaestos, and other sites in Crete has disclosed, not merely the existence of a people whose form of civilisation was the earliest in Europe, but their daily life, games, amusements; their art, religion, writing—though hardly yet their language; their physical characteristics, dress, the homes they lived in. A huge palace, as big as Buckingham Palace, has been unearthed at Knossos. It has a drainage system which an eminent Italian archæologist has described as "absolutely English," and which certainly anticipates the hydraulic engineering of the nineteenth century.

If turning in one's grave can be anything but a figure of speech, Charles Kingsley must have had a restless time in the last twenty years. In *The Heroes* he was writing what he himself described as a "fairy story" for his children. We know now that, in many ways, he was unconsciously writing history. When, for instance, he said that the palace of King Minos at Knossos was like a marble hill, he was unaware that there actually lived a King Minos in Crete, that his palace stood on a hill at Knossos, and that it was built, if not of marble, at any rate of stone.

It is astonishing to reflect that up to the last half-century the whole culture of classical Greece was regarded as an original thing, springing suddenly into a glorious existence. The sculpture and architecture, philosophy, oratory, and drama of the fifth century B.C. were accepted as the spontaneous first-fruits of Greek genius. The history of Greece went back only to the eighth century; beyond were the Dark Ages and nothing. It was true that before Æschylus, Sophocles, and Euripides there had been the shadowy poet Homer. He had sung of men and deeds which seemed to echo from those Dark Ages. But he certainly, so we thought, was the beginning of all things. He has now been shown to have been the end of a good many things.

Ignorance of the real beginnings of Greek civilisation becomes remarkable when one recollects how much was known of other origins in the Near East. In Egypt and Babylonia the old traditions had been passed on by later generations to Greek writers, who preserved for us, no matter how imperfectly, the necessary connecting-links. But the corresponding phase of Greek civilisation was completely shut off; there was no suspicion even of its existence. The complacent acceptance as myths—which is the same thing as the tacit and complete disbelief—of the epic stories which centred round Agamemnon and the Homeric heroes was never challenged up to the middle of the last century. "To analyse the fables," said the historian Grote,[1] "and to elicit from them any trustworthy particular facts," would be "a fruitless attempt."

STRATA SECTION FROM PALACE OF KNOSSOS.


N
S
SURFACE LEVEL
ROOM OF THE "BÜGELKANNES"
(LATE MINOAN
0·80
CLAY FLOOR
INSCRIBED TABLETS
PLASTER & CLAY FLOOR
FALLEN MINIATURE WALL PAINTING
PLASTER & CLAY FLOOR
LATER PALACE II (LATE MINOAN I & II.
WALL A
PLASTER
0·60
KNOBBED PITHOS (DIAM. 1·10 METRES AT BASE)
LATER PALACE I. (MIDDLE MINOAN III.)
PLASTER & CLAY FLOOR
ROUGH STONE FLOOR
WALL B
WALLED PIT
WALLED PIT
PROBABLY DESCENDS 7 METRES EARTH FILLING
EARLIER PALACE (MIDDLE MINOAN

(From R. M. Burrows's *Discoveries in Crete*.)

Such was the outlook of Grote's contemporaries. It was an outlook that was destined to be revolutionised in a simple way. A poor boy named Schliemann had learned these Greek stories from his father, and his child's instinct told him they were literally true. He determined to find the walls of Troy. Late in life, after hard saving, he had money enough to put his faith to the test. He went to Hissarlik, the spot in Asia Minor where the town of Troy was said to have stood. He dug into the earth, and buried walls were his reward. They proved in the end, however, to belong not to the Homeric city, as Schliemann naturally thought, but to another which had existed on the same site a thousand years earlier—he had dug within and through the Homeric walls without seeing them. From Troy he went to Mycenæ and Tiryns on the Greek mainland, and the sum of his achievement was the definite disclosure of the "Mycenæan" civilisation, which, as we now know, flourished from about 1400 B.C. to 1100 B.C. He thereby justified his faith in the historic background to the Homeric poems. One can readily imagine the excitement which accompanied such discovery; as when Schliemann sent a telegram to the King of the Hellenes announcing that he had found the tomb of Agamemnon at Mycenæ. One almost wishes it had been literally true, as Schliemann at the time thought it was. In any case, he laid the foundations for the whole structure of modern prehistoric research.

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[1] *History of Greece* (2nd ed., 1849), p. 223.

Prominent in that work of research has been the opening up of Crete. The discoveries of Sir Arthur Evans and other excavators—British, American, Italian—have proved that the Mycenæan culture revealed by Schliemann was itself only a late and even decadent phase of a great Mediterranean civilisation which centred round Crete.

II

The primitive Ægean people played a great part in the activities of the Near East. This part lasted through several thousand years, and the scene of its action embraced every shore of the Eastern Mediterranean. Crete was a land, as Homer[1] says, "in the midst of the wine-dark ocean, fair and rich, with the waters all around." It was the natural centre towards which the mainlands of Greece, Asia Minor, and Egypt converged, especially as its irregular coast afforded good harbours for the small ships of that remote time.

The first settlement of man in Crete took place at Knossos, in the later or "Neolithic" Stone Age. This fact is established by the nature of the relics found at the lowest level in the excavations, the level which represents the earliest period in time. Phaestos, on the south side of the island, received its first inhabitants at a later date—a fact for which we are indebted to the pottery that has been discovered there. The establishment of this fact is indeed a typical instance of the great value of pottery as archæological evidence. The earliest ware found at Knossos is unornamented; the next is improved by "incised lines"—that is, lines cut in the clay with a pointed instrument and often filled in, for greater effect, with a white substance. At Phaestos, on the other hand, the pottery found lowest down is already in this second stage in its artistic evolution, the inference being that the men who settled there took the art with them at the point to which it had been developed by the Knossians.

After the "Stone" Age came the "Bronze" Age. Men realised that not stone, but a mixture of copper and tin, provided the best material for instruments. A picturesque touch is added to this discovery by an Italian archæologist, Angelo Mosso, who in *The Dawn of Civilisation* gives reason for believing that, even at so remote a period, the tin was brought to Crete from Cornwall. He goes so far as to point out the actual caravan route by which the tin was transported! It was during this Bronze Age, which lasted about 2,000 years, that Cretan civilisation reached its highest level. Sir Arthur Evans has given to it the picturesque name "Minoan," and has divided it into three stages—Early, Middle, Late—each with three subdivisions. Early Minoan I (E.M. I) begins about 2800 B.C., Late Minoan III (L.M. III) ends about 1000 B.C.[2] These nine periods are a happy play upon "the nine seasons" during which Homer[3] speaks of King Minos as reigning in Knossos: "And in Crete is Knossos, a great city, and in it Minos ruled for nine seasons, the bosom friend of mighty Zeus." The term "Minoan" should be carefully distinguished from "Mycenæan." After Schliemann's discoveries at Mycenæ and Tiryns, the term "Mycenæan" was used in a general sense, to cover the whole prehistoric Ægean civilisation; but now that Crete has put Mycenæ into its right perspective, the term "Minoan" is used to indicate the earlier and greater phase, while "Mycenæan" merely covers the latest phase; the whole being designated "Ægean" or "Mediterranean." There is, to complete the nomenclature, a further epithet, "Cycladic," which is sometimes substituted for "Minoan" when one speaks exclusively of the island sites outside of Crete.

With the fall of Knossos, which took place shortly before 1400 B.C.—I again adopt Dr. Burrows's dating—the centre of influence in the Ægean passed over from Crete to the mainland of Greece, and the true "Mycenæan" period started. Thereafter followed the Dark Ages, which themselves immediately preceded "historical" Greece. Recorded Greek history begins about 800 B.C.

(*To be continued next month*)

Dr. R. R. Marett's important book, *Psychology and Folk-lore*, discusses the methods of the study of man, and should be of great interest both to psychologists and students of folk-lore, while it will assist in interpreting history as the expression of our common human nature. The book is published by Messrs. Methuen at 7s. 6*d*. net.

The Lure of the Map is the title of a series of essays on the literature of travel, the relation of travel and romance, and the fascination of the map. The book is by W. P. James, and Messrs. Methuen are the publishers.

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[1] *Odyssey*, xix, 172.

[2] See *The Discoveries in Crete*, by Dr. Ronald M. Burrows, p. 98.

[3] *Odyssey*, xix, 179.

Immunity and Plant Diseases

By Geo. C. Gough, A.R.C.Sc., B.Sc.

Immunity from, or resistance to, a disease in animals is an old tale, and a vast amount of literature in many countries testifies to the work that has been done on the subject. Toxins and antitoxins are now almost household words. The immunity of plants to disease has only recently come into the realms of scientific research, but with animals it is now possible to inject a serum containing an antitoxin which will give immunity to a specific disease—recent notable examples being diphtheria and tetanus—such serums being prepared in large quantities and on a commercial scale.

Thousands of pounds are lost yearly by the action of plant and animal parasites on plants, and at least 10 per cent. of each crop is lost by such parasitic action. It is evident, therefore, that a considerable increase of food could be obtained if such diseases could be held in check. Generally speaking, animal pests are more easily controlled, whether naturally by means of their parasites, or by spraying the plants with some poisonous wash.

On the other hand, diseases caused by fungi are not so readily checked, as in very many cases the first signs of their presence are the wilting and death of the plant.

It would therefore be of the greatest service if it were possible to confer immunity from disease on plants. Our knowledge of the cause of immunity in plants is so slight that the question of the preparation of antitoxins is not a practical proposition at the present time, and even if it were, it would be seldom possible to apply them to the plants. What little knowledge we have suggests that immunity may be due to various causes, such as the death of the germ tube of developing spore of the causal fungus on entering the cells, the presence of certain salts or acids, or even the amount of bloom produced on a leaf. In the latter case resistance is only due to the fact that water, in which spores can develop, rolls off.

Fortunately this natural resistance to certain diseases in many varieties of plants can be made use of by hybridists who have been able to produce immune varieties.

It is regrettable that such natural resistance is often associated with poor cropping or feeding qualities, and the efforts of breeders are put forward to associate immunity with other good qualities. In this connection mention must be made of Professor Biffen's efforts to associate immunity from rust[1] in wheat with a good cropping "strong" variety, as these have met with gratifying success. At least two of his varieties are now being grown commercially.

In Australia, Farrar has produced wheat hybrids which are rust-resistant, and one of these is being grown by farmers; while in America, Norton has produced a rust-resisting asparagus, which is grown on a commercial scale.

Pure selection has been used to a considerable extent in the United States. A plant is noted in a field as being resistant to some epidemic disease which has killed all its neighbours. The progeny of this is then subjected to attack by the same disease, and by a similar weeding-out process a strain is produced which is mainly, if not entirely, resistant to the disease in question. Thus strains of cabbage and tomatoes resistant to wilt disease have been raised in this fashion.

It is important to realise that the resistance thus conferred is like that amongst animals, only to a specific disease, so that a plant or animal may be rendered immune to one disease only to fall a victim to another.

The most important instance of immunity is that of certain potatoes from a virulent disease known as Wart Disease. This disease has been known for some years as a soil pest in certain districts, and is gradually spreading over Great Britain. It is caused by a lowly fungus which may lie in the soil for many years, and as no cure is known for it, it continues to attack potatoes, if planted year after year, causing ugly outgrowths on tubers and stalk. In very few years warts only are found, and no potatoes are formed. The disease is so destructive and widespread that it has been made notifiable by the Ministry of Agriculture, and the movement of seed potatoes from infected districts is regulated. In 1908 an inquiry was made by the author, who noticed that certain varieties were grown by cottagers and others in infected land without being attacked by the fungus, and this led to trials of different varieties in infected soil.

Official trials are now conducted every season by the Ministry, and as a result the list of varieties which have proved immune from this disease is now over 100. Although the reason for it is still unknown, the immunity is absolute, and no variety which has been officially classed as immune has taken the disease.

A striking experiment in this connection is to plant side by side in infected soil tubers of Great Scot and Arran Chief (or King George and British Queen), so that plants grow up intertwined. The tubers are similar, and would not be distinguished by the ordinary person. Yet on lifting the crop at the end of the season, the Great Scot will produce a good crop, free from any sign of warts, while the Arran Chief may only show warts and not a sound tuber. In the same way the King George will be free and the British Queen attacked.

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[1] Rust, a fungus disease showing first as rusty streaks on leaves of cereals, and causing a great reduction of crop. Many other plants have their "rusts."

So important and so certain is the immunity that the administration of this disease by the Agricultural Boards in the British Isles is based on the fact, and where the disease is present only immune varieties of potatoes may be planted. Raisers of potatoes are therefore exerting every effort to produce such resistant varieties having the good cropping and other qualities of those in commerce at the present time, and considerable success is being achieved. If a potato immune both from Wart Disease and ordinary potato disease or Blight (Phytophthora) could be raised with the cropping qualities of some of the ordinary commercial potatoes such as Up-to-date and King Edward, the food-supply of potatoes in the British Isles would be increased by at least 20 per cent. This ideal is not beyond the bounds of possibility, as, although no potato is immune from Blight, several—for example Flourball, Champion, and Templar—are immune from Wart Disease and largely resistant to Blight. They have disadvantages which militate against their general and commercial use, but breeders hope to get rid of these, while still maintaining their resistance to disease.

The literature on Immunity in Plants is very scanty, and no book is published on the subject. A recent general account is that by Dr. Butler in the *Proceedings of Second Meeting of Mycological Workers in India*, 1919. Reference may also be made to a paper by Otto Appel in *Science* for May 28, 1915. As regards Wart Disease, a full bibliography is given in the author's paper in the *Journal of the Royal Horticultural Society*, June 1920.

The Revival of Learning and the Capture of Constantinople

By R. B. Mowat, M.A.

Fellow and Assistant Tutor of Corpus Christi College, Oxford.

THE Revival of Learning is the most momentous fact in the history of Europe. With the decline and fall of the Roman Empire in the fifth century A.D., a great part of the literature and learning of the ancient world disappeared for centuries. The "Dark Ages" ensued, when life was very insecure, and education, except within the walls of certain fortunate monasteries, scarcely existed. The "Feudal System," according to which every man had a fixed place in the community, under a master, saved society in the Middle Ages, but at the expense of all political, social, or intellectual freedom.

The Middle Ages may be considered to begin, and the Dark Ages to have ended, with the coronation of Charlemagne as Emperor at Rome in A.D. 800. From Charlemagne's time onward, the rôle of the Church in moulding the manners and minds of men becomes more and more effectual, so much so that the eleventh and twelfth centuries have been called "the Ages of Faith." It was indeed faith, rather than reason, that ruled in the Middle Ages; and although the services of men like St. Anselm or St. Thomas Aquinas to the human intellect must always be recognised, it still remains true to say that the Middle Ages were marked by a certain rigidity; every man was definitely fixed in his class, in his profession, in his corporation; the use of the human reason was strictly limited, and investigation and argument were conducted according to fixed rules. One of the greatest and most open-minded of the Mediævalists asserted that the human intellect was not meant to be able to discover everything; for if it had been able to do so, there would have been no scope for the life of Christ in the world:

> State contenti, umana gente, al *quia*;
> Chè, se potuto aveste veder tutto,
> Mestier non era partorir Maria.
>
> (Dante, *Purg.*, iii. 37.)

> Seek not the wherefore, race of human kind;
> Could ye have seen the whole, no need had been
> For Mary to bring forth.

During this long mediæval period, this time of intellectual rigidity, the greater part of classical literature was not studied; indeed, many of the classics which we now have were not at that time known to exist at all—such as Cicero's *Letters to Atticus*, of which the manuscript was not discovered till 1345. The great secular book of the Middle Ages was Virgil's *Æneid*. Comparetti, in his work *Vergil in the Middle Ages* (*Virgilio nel medio evo*), has shown how this poet was regarded as a prophet, a grammarian, a wizard, and as a universal compendium of learning.

Thus the learning of the Middle Ages was chiefly derived from Latin works, and from only a restricted number of Latin works. Something was known of Greek literature, but only through translations—some of Aristotle's works, for instance, were known through Arabic translations, which in turn were rendered into Latin. It was not merely, however, that Hellenic literature had disappeared; the Hellenic spirit, the spirit of freedom and inquiry, had also been forgotten. The Middle Ages ended when classical studies, and particularly the study of Greek literature, revived: then the veil was lifted, and the new birth, the Renaissance, of Europe took place.

The date of this Renaissance has been conventionally placed at the year 1453, when Constantinople, the capital and last stronghold of the "Greek" or "Byzantine" Empire, fell before the Turks, under the Sultan Mohammed II. It has been assumed that many Greek scholars, bearing with them ancient Greek manuscripts, fled from Constantinople in the face of the Turks, and spread classical learning throughout Western Europe. To support this theory, however, practically no facts can be advanced; the fall of Constantinople makes a landmark in European history, but its influence upon the Renaissance appears to have been comparatively little. By closing the land-routes to the East, the Turks may have helped to turn men's minds towards finding out the ocean-routes in the West, but they cannot be said to have had any part in producing, by their misdeeds, the revival of learning. This revival, and its consequent freeing of the human intellect, had already been going on for more than a century when Constantinople fell.

Knowledge of the Greek tongue was never quite dead in Italy at any time in the Middle Ages, because in the extreme south of Italy, in Calabria, the towns had been originally colonised by Greeks, and the use of Greek speech had never since died out. Moreover, until the middle of the eleventh century the Byzantine Empire retained some shreds of its authority in Italy, and throughout the rest of the Middle Ages, diplomatic communications and personal missions between Italy and Constantinople were quite frequent. Greek manuscripts, copied by scribes in Byzantium, were conveyed over to Italy as presents, or perhaps for sale. Petrarch, who flourished in the middle of the fourteenth century, possessed a copy of Homer, which came from Byzantium; he was unable to read it, however. Another great contemporary Florentine, Boccaccio, both possessed and could read Greek classics. It was in the year 1360 that, owing to the efforts of Boccaccio, a chair of Greek was instituted at Florence, the first professor being Leo Pilatus, a Calabrian who had learned Greek as his mother-tongue in South Italy. He was induced by Boccaccio to translate the *Iliad* into Latin. Mr. A. C. Clark, the Corpus Professor of Latin at Oxford University, who has been lecturing on "Scholars of the Renaissance," states that, if any specific date must be given for the beginning of the scientific study of Greek, it should be the year 1396, when Manuel Chrysoloras, an accomplished scholar from Constantinople, began teaching Greek in Florence. His career as a teacher and as a man of learning lasted till 1415, by which time classical studies may be said to have been re-established in Western Europe.

The Revival of Learning, however, was not wholly Greek. In the middle of the fourteenth century there was also a great revival of Latin studies. Petrarch, who lived from 1304 to 1374, was a Latinist of the highest quality; it was he who discovered the above-mentioned manuscript of Cicero's *Letters to Atticus*, at Verona, in 1345. But the greatest scholar of the Early Renaissance was Poggio, who was born in 1380 and lived till 1459. His most important work for classical scholarship was done in 1414 and 1415, when he was one of the Papal Secretaries at the Council of Constance. In the intervals between his attendances at the Council, he visited the chief monasteries of Switzerland and Burgundy, and also Cologne, and searched their libraries. It is to his initiative and energy that we thus owe the rediscovery of many classical manuscripts, in particular a number of Cicero's speeches, which had lain forgotten for centuries in the monastic libraries. It was about fifteen years after Poggio had discovered these manuscript treasures that Laurentius Valla began his epoch-making work in critical scholarship; his method of examining texts and manuscripts led to the separation of the genuine from the spurious. He is best known for his exposure of the "Donation of Constantine," the supposed fourth-century grant of temporal dominion to the Papacy.

Thus the Revival of Learning, the modern zeal for education and inquiry, must be dated from the beginning of the "Later Middle Ages," from about the early years of the fourteenth century, if not earlier. Some of its greatest achievements had taken place long before Constantinople fell, in 1453, and it cannot be proved that this event had any particular influence upon the course of the Renaissance.

THE REVIVAL OF LEARNING IN THE LATER MIDDLE AGES

The Early Renaissance may be still studied with advantage in Pater's *Renaissance* and Symond's *Renaissance in Italy* (1897). Creighton's *History of the Papacy* (1882) and Lindsay's *History of the Reformation* (1908) are classical works. Scartazzini's *Companion to Dante* (1893), translated by Butler, gives good information on Dante's learning. The classical work on the early history of Humanism is Voigt's *Die Wiederbelebung des classischen Alterthums*, which has been several times re-edited. The history of discoveries of manuscripts in theLater Middle Ages is given by Walser in *Poggius Florentinus: Leben und Werken* (1914), and in Sabbadini, *Le scoperte dei codici latini e greci ne' secoli* xiv *e* xv, 1905. The standard work on the history of scholarship is Sandys, *A History of Classical Scholarship* (1908). Mowat, *The Later Middle Ages* (1917) is a general account of the period.

Popular Chemical Dictionary. By C. T. Kingzett, F.I.C. (Baillière, 15*s.* net.)

The Origins of Mexican Mythology

By Lewis Spence

Author of "The Civilisation of Ancient Mexico," "Myths of Mexico and Peru," etc.

THE mythology of the Aztec people of Ancient Mexico has been unaccountably neglected by British students of Comparative Religion. German, American, and French scholars have been quick to grasp its importance and significance, and their researches have succeeded in placing it on an equality of standing with the faiths of Egypt and Babylonia. It is singular that British scholarship, which has done more than any other for the advancement of the science of Comparative Religion, should have disregarded a source from which so many striking illustrations of the development of religion can be drawn.

British apathy towards the subject of Mexican Archæology and Mythology would seem to arise out of the rather unusual difficulties which have hitherto beset the initial efforts of those who desire to pursue its study. The languages of Mexico and Central America are complex and not easily mastered, and the works of the older Spanish authorities upon myth and ritual are numerous, expensive, and not easily obtained unless in the best-equipped libraries.

But supposing these obstacles to be overcome by the enthusiastic student, he still finds himself opposed by others of even greater magnitude. He must make an exhaustive study of the native calendric and hieroglyphic paintings or codices, which at the first bewildering glance appear as a mass of writhing figures and inextricable symbols, executed with what would seem to be a total disregard of all method. Towards the comprehension of these, he will find a certain guidance in the works of Professor Eduard Seler, of Berlin, who has laboriously described and annotated them. But, even so, he will meet with many disheartening admissions of ignorance on passages of obvious importance, and, if he possess independence and initiative, he will, in the event, prefer to resort to a first-hand examination of these manuscripts.

However valuable the student may find a perusal of the painted manuscripts of the Ancient Mexican peoples, he will soon discover that their contents are, for the most part, limited to a record of the periods at which certain religious festivals were celebrated. These are usually accompanied by pictures of the gods, which will assist him to a comprehension of their general appearance, costume, and the insignia which illustrate their deeper significance. Here and there, too, he will find pictorial representations of myths and festivals. But it is rather from the prolix and elaborate works of the Spanish Colonial writers of the sixteenth and seventeenth centuries that he will first extract the material which will enable him to form a just estimate of the religion of the Ancient Mexicans. In the writings of Sahagun, Torquemada, Mendieta, and others, and the annals of Spanish-speaking natives in particular, he will encounter those facts which will help him to solve the riddles of the manuscripts.

During the last few years of a long apprenticeship to the study of Mexican religion, my endeavours have been directed to smoothing the progress of those who will come after me, and I hope to complete shortly a volume, somewhat in the nature of a handbook, bringing together all available data concerning each of the gods, especially as regards costume, symbols, etymologies, myths, and representations in painting and sculpture. But in such a brief paper as this I must confine myself to that phase of it which I have recently been considering more especially—the origin of the more important of the Mexican gods, i.e. the original forms in which these appear to have presented themselves to the Aztec mind.

In course of time one outstanding fact will bulk before the student to the diminution of all others. The religion of Ancient Mexico, he will come to see, was originally developed out of an urgent local need —the need for rain. At the period when Cortéz and his Spanish cavaliers invaded Mexico, the native faith of that country was nothing more than a vastly elaborated rain-cult, similar in its general tendency to that which still prevails among the Pueblo Indians of New Mexico, yet broader in outlook, more complex, and higher in moral endeavour, although stained with the cruelties of human sacrifice. The necessity for rainfall, by which alone the parched soil of Mexico could be rendered fit for the growth of maize, practically obscured every other consideration in the native mind. Once that salient fact is grasped, much will have been done towards the understanding of Mexican religion as a whole.

At a late stage of its development, practically all the gods of Mexico came to be included in the great national rain-cult, but in some cases their early forms show signs, if I am not mistaken, of tribal or local origin quite foreign to it. This is especially the case with Uitzilopochtli, who until now has been labelled as a "war-god," and whose name has been translated "Humming-bird-to-the-left" or "Humming-bird-of-the-South." I believe that this god was at first a personification of the maguey plant *(Agave americana)*. A certain variety of this plant, so common in Mexico, was known to the Aztecs as "beak of the humming-bird," probably because of the resemblance its long spiky thorns bear to the sharp beak of that graceful little creature, which suspends its tiny web-like nets from the leaves of the plant in question. I find in an old manuscript by a native writer that another of the names by which the god was known was "Snake of the Maguey," and still another and better known title of his was Mexitli, or "Hare of the Maguey," from which one of the districts, and later the whole city, of Mexico took its appellation. Elsewhere he is called "Thorn that speaks oracularly," and the maguey plant is one of the elements of the hieroglyphs which represent his name. On the day of his movable festival, too, says Friar Sahagun, the proprietors of the maguey plantations and the publicans who sold the *octli*, or intoxicating juice extracted from the agave, cut their plants in the belief that they would yield more abundantly if tapped at such an auspicious time, and the first of the *octli* was afterwards offered to the god.

The etymology of the name Uitzilopochtli also assists the theory that he was developed from some idea connected with the maguey. The first part, *Uitzil*, is thought to be derived from *uitzilinin*, "humming-bird." *Opochtli*, while it certainly means both "left" and "south," as many authorities state, also signifies "wizard," "as," says Torquemada, "some folks believe." For the word "left," in Mexican, as in Latin, also implies "sinister," "inauspicious," "malign," therefore "magical" or "wizard-like." Sahagun calls Uitzilopochtli "a necromancer and friend of disguises" (that is a shape-shifter); and we have already seen that the idea of oracular speech was connected with him probably because of the intoxicating nature of the juice of the plant he personified, which, in its effects, also appealed to the native mind as serpentine or venomous. I therefore believe the name Uitzilopochtli to mean "Humming-bird Wizard." The humming-bird, which builds its nest in the maguey and is seen to issue therefrom, would come to be regarded as the living spirit which inhabited that plant. But it is possible that a certain amount of confusion arose between the words *uitzilinin*, "a humming-bird," and *uitztli*, "a thorn," and this may have assisted the belief that the god took bird-shape. Indeed, the name may originally have meant "the Thorny Wizard," and have had reference to the plant alone, later (by a process of punning or "disease of language" well known to students of mythology) taking the form referred to above.

The beginnings of the god Tezcatlipoca, whose name means "Smoking Mirror," and who has been labelled a "wind god," are quite as rudimentary. I believe him to have been a personification of obsidian, a kind of flint especially sacred to the Ancient Mexicans, as it provided the sacrificial knives used by the priests.

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Acosta states that Tezcatlipoca's idol was made of obsidian, and he is represented in one of the manuscripts as wearing obsidian sandals (footgear often indicates the nature of a person or deity in Mexican heiroglyphic painting). He was certainly the god of the sacred obsidian knife of sacrifice, and he is occasionally symbolised by that implement, which sometimes takes the place of one of his feet. I believe, too, that the net-like garment worn by this god above his other attire is a development of the mesh-bag in which Mexican hunters carried flints for use as spear- and arrow-heads.

But there is a much stronger connection between Tezcatlipoca and the obsidian stone. From this mineral mirrors were cut and polished, not only for the ordinary purposes of the toilet, but for the use among wizards and sorcerers as aids to divination. Into the depths of these the wizard peered to read the riddles of the future, just as the modern crystal-gazer "scries" in her polished globe. One variety of this stone was called *tepochtli*, or "wizard-stone," from which, it seems to me, by a process of etymological confusion, Tezcatlipoca may have received one of his minor names, Telpochtli, "the Youth." Acosta and other writers tell us that this god was represented with a magical mirror called *tlachioloni*, "his glass to look in," in which he was able to witness the deeds of all mankind, precisely as the priests were supposed to do.

Tezcatlipoca is frequently referred to as "a shadow," "a ghost," and this aspect of him, I believe, refers to the misty shapes seen by the sorcerer in the magic glass. Thus, from the shape beheld in the seer's mirror, Tezcatlipoca came to be regarded as the seer himself. The wizard-stone became personalised and developed into a god, and its reflections became his attributes.

But Tezcatlipoca as the obsidian also came to be thought of as one of those magical stones by the agency of which great wind-storms can be raised, and of which there are numerous examples in all mythologies. He has been identified with the Central American god Hurakan, from whose name we get the word "hurricane." He was therefore thought of as a god of wind. But it was chiefly through the fear inspired by his magical prowess that he came to be regarded as chief deity of the Mexican pantheon. His name, "Smoking Mirror," arose, I think, from the cloudy appearance which obscures the surface of a scrying-glass when one has gazed into it for some time.

The god Quetzalcoatl, regarding whose significance there have been many striking differences of opinion, has at one time or another been identified with the wind, the sun, the moon, the planet Venus, and the apostle St. Thomas! His myth, of which there is an embarrassing number of variants, tells of his arrival in one part or another of Mexico or Central America, where he laboured to civilise the people and to introduce the arts of agriculture and settled existence, founding the culture known as the Toltec, which flourished at Tollan. His mission accomplished, he was driven from the country by the "magician" Tezcatlipoca.

In my view, the physical phenomena which occur in connection with the courses of the winds typical of the Mexican plateau provide by far the most simple and natural explanation of the nature of the god Quetzalcoatl. From April or May to the beginning of October the trade-wind blows in a north-easterly direction from the coast over the plateau, bringing with it abundance of rain and accelerating vegetable growth. At the end of that period, however, it is invariably modified by the local monsoon, which interrupts it over wide areas, or in certain districts invades it in violent cyclonic storms, dissipating its energies and altering its course from north-east to south-west. Quetzalcoatl resembles the gentle trade-wind which ushers in the growth-making rains. His reign of peace, plenty, and fertility over, he comes into opposition with Tezcatlipoca, who represents the monsoon, and who chases his rival from "city to city," ravening at him like a tiger (says Mendieta), and at last hustling him out of the country. This attempt at elucidation refers, of course, to what seems to be the earliest form of his myth. Its later forms are surprisingly complex, but are all capable of being referred back to the original nature-story. The etymology of his name, too, which is usually translated "Feathered Serpent," seems to me to indicate the

THE GOD QUETZALCOATL.

From the author's *The Civilization of Ancient Mexico* by kind permission of the Cambridge University Press.

water carried by rain-clouds, the serpent being the symbol of water in America as elsewhere.

These remarks must not be taken as applying to the later and more complicated developments of the gods to which they have reference, but to their earliest forms alone.

Aerial Warfare in Ancient India

By Ikbal Ali Shah, M.R.A.S., F.R.G.S.

In the ancient literature of the East, we come across many allusions to the fact that the science of aviation was conceived in India as early as 500 B.C. In the carved rocks of the Southern Indian caves is held the key to this secret art of pre-Brahmanic age, just as the Pyramids of Egypt and the Topes of Kashghar are the respositories of an artistry more than half forgotten. The figures incised in the caves of Ellora do not give us any satisfactory account of ancient Hindu aerial machines—their plan of construction or what they could do—but those images lend colour to the statements made in the traditional books of the Brahmans regarding the use of "flying carriages" in the earliest period of Indian history.

These references are encountered notably in the Ramayana and Mahabharatta. These works are by no means confined to one period of time, but, like most sacred books, they consist of materials of different dates, illustrating the progress of the social and religious evolution of the Brahmans. The great Hindu epics were written to celebrate the exploits of kings and the conflicts of an internecine war. References to flying during that period are very clearly indicated in the Ramayana. In this stirring poem, which was compiled about the year 500 B.C., we learn that Rawun, a King of Ceylon, used to fly over his opponents' armies and not infrequently caused them severe loss.

The writer of that book mentions, further, that after a fierce struggle between the Brahmans and the King of Ceylon, in which Rawun was defeated and slain, his wonderful "flying carriage" fell into the hands of Ramchander, the Hindu chief, who flew in it from Ceylon to his capital at Ajudhia, in Northern India.

Apart from the notices of flying in the semi-religious literature of India, we find that the historical poets of those distant times also celebrated the subject. The greatest of the ancient Hindu poets, Kali Das, treats of the aerial journey of Ramchander in a heroic

(Continued on p. [illegible])

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poem entitled "Ragho-Buns." A lesser poet, too, who flourished some 200 years later, in a description of the war between rival Hindu chiefs led by Risho and Arjan, speaks of a "flying carriage" which did much to hamper the movements of an army. In the Mahabharatta mention is made of a king presenting a brother monarch with a flying machine as a token of friendship. Also in Puranas one reads of a "huge flying carriage possessed of the power of travelling by itself."

In perusing the Sanskrit classics one comes across numerous aeronautical terms. Some of the more interesting of those may, perhaps, be quoted:

Vaman-yanu, meaning: To propel a flying carriage.
Vaman-Chirya, meaning: To fly in a flying carriage.
Vaman-Perbhoot, meaning: A procession of flying carriages.
Vaman-Arj, meaning: One who works a flying carriage (an aeronaut).

Such phrases are very frequently met with in the Hindu epic writings. It is generally admitted that, when a language is in process of formation, new words and terms are coined as the necessity arises. Is it venturing too far, therefore, to assert that, if flying machines had not existed in Ancient India, such phrases could surely never have come into common use? Why, then, do we find them so deeply embedded in old Sanskrit?

That Rawun and other epic heroes were not without means to strike a shrewd blow at an invader from the air is manifest from further allusion in the Ramayana, which described the "explosive torches" that they hurled from their machines upon the heads of their enemies.

The manner of making these primitive bombs is treated of in several ancient manuscripts which exist in India. There are, it is well known, recipes for making fireworks both for purposes of destruction and purposes of pleasure. Rural poets have rendered these recipes into colloquial verse, and in the Indian villages which lie beyond the railway zone there are few rustic youths who cannot recite these ancient formulas. The pandits—priests—state that these recipes are almost contemporary with the great epic poems.

The method of manufacturing these "aerial torpedoes" was as follows: a pasteboard cylinder about two feet long was filled with charcoal, saltpetre, and nitre, mixed with nails and sharp pieces of glass. The fuse was of coconut fibre, which was ignited before the "bomb" was cast.

According to common usage, the verses which refer to these fireworks are to be recited as sacred passages. Some priests even go so far as to prohibit the vulgar from learning them. Certain rites and ceremonies are supposed to be celebrated prior to the manufacture of these explosives, and occasionally the village pandit opens the proceedings in person. All these facts afford strong presumptive evidence as to the antiquity of the art of fireworks in India; and those who are familiar with the religious traditions of the Hindus cannot deny that the practice owes its sanctity to its alleged association with the wars between the Brahmans and the unfaithful King of Ceylon.

In ancient Sanskrit records we have, then, not only a most interesting record of conception of aircraft in India in 500 B.C., but we are also afforded a glimpse of their activity. It would seem that the modern phase of aeronautic development is only a replica of more ancient effort, and here as elsewhere history has repeated itself.

The Modern Uses of Rubber

A STOCK phrase is that "there is nothing like leather," but at the present day this should be changed into "there is nothing like india-rubber," as never at any time have its uses been so varied and its commercial demand so great. One sure sign of an article's utility is the number of substitutes placed upon the market, and of substitutes for rubber there have been scores, not one of which possessed all the qualities of the genuine article; and although very many nearly approached it, yet they were short of one or more essential features. Rubber is a curious substance, much more so when manufactured than in the raw state, the quality which so far renders it unique being its high degree of elasticity, which it shows to the best advantage in the rubber threads used for those textiles known as elastic. Motor tyres, waterproof fabrics, hose piping, and tobacco pouches are all dependent on that elastic quality of the rubber, which causes it to spring back to its original state; whilst a host of other articles, no less useful, are made from the hard form of it commonly termed vulcanite. Owing to the many uses to which rubber is now put, there is a considerable demand for old rubber materials, such as worn-out motor tyres, door-mats, tubing, etc., all of which are utilised again for something after the style of working up shoddy into fresh material.

Existing as a natural gum in the stem or trunk of a large number of tropical plants, rubber in the natural state forms a thick milky fluid which oozes out from cuts made in the bark of the growing tree, and is collected in small tin cups which are cemented to the trunk with clay. On emerging the juice is whitish, but darkens and coagulates, with time and exposure, into a dingy brown mass. The shapes in which it is imported vary largely according to circumstances; some being in the form of round balls, known as nigger heads, and other in blocks, thimbles, cakes, and bottle-shaped masses. Chemically, rubber or caoutchouc is a complex substance and consists of several different gums. These bodies have varying degrees of solubility. Water, of course, has no action upon raw rubber, but it dissolves in a mixture of carbon bisulphide, benzene, and naphtha. No single solvent will dissolve it entirely, some of its constituents being acted upon more quickly than others by the various solvents used, and the raw substance seems to consist of a highly porous network of cells. At a temperature of 10° C. raw rubber is a solid body with very little elasticity, whilst at 36° it is soft and elastic to a high degree, and is capable of being stretched to sixteen times its length. Further increase of temperatures lessens these elastic qualities, and at 120° C. it melts. In the raw state rubber has several peculiar properties, one of which is that, after being stretched and cooled suddenly in the stretched condition, it retains its new form, and only regains its former shape on being warmed. Another striking feature is its strong adhesive capacity; this is so powerful that the raw substance cannot be cut with a knife unless the blade is wet, and freshly cut portions, if pressed together, form a homogeneous mass.

The first use of rubber gum was for waterproofing fabrics, and in 1823 a solvent was found by Charles Mackintosh which allowed a thin coating to be applied like paint. Owing, however, to its sticky nature, it made very little headway for waterproofing purposes, until, in 1839, an American named Goodyear found that a mixture of rubber and sulphur heated together produced a body very different from the raw gum, being elastic at low temperatures and free from stickiness right up to its melting-point. This discovery, known now as vulcanising, opened up an important future for rubber, and by varying the amount of sulphur, together with the heat and duration of the process, products are obtained which range from the softest flexible tubing up to the material used for making the barrels of fountain-pens and the mouthpieces of pipes. On broad lines the outline of the vulcanising process is as follows: The raw material is well masticated between hot rollers, and is incorporated with the necessary amount of sulphur; it is then pressed into moulds which clamp together and prevent any loss of shape owing to the contraction of the rubber. Heat is now applied, and, when the process is over, the rubber will be found to have taken the shape of the

[*Continued on p. 188*

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mould permanently, being now much more elastic than the raw gum, and perfectly soluble in the usual solvents. Rubber possesses great adaptability for mixing with other bodies, a fact which manufacturers are perfectly aware of, and articles solely of the pure vulcanised gum are only made for special purposes. Among the many substances which lend themselves to combination with rubber are, zinc sulphide, white lead, asbestos, litharge, chalk, hemp and boiled linseed oil. By means of judicious admixtures of these, rubber can be brought to any degree of hardness and the cost can be manipulated to the makers' if not to the users' satisfaction. Low-priced rubber articles which are required to have the life and elasticity of good rubber cannot be recommended, for the very excellent reasons that good material is expensive, and all makers must have a profit.

A popular but utterly erroneous impression is that old articles of rubber, like old brass and copper, can be " melted again." The only possible way of melting rubber is to heat it, and this entails absolute destruction, leaving only a sticky, evil-smelling oil behind it, which never again sets into the old solid form. Of course, second-hand rubber is put to many purposes, but this can only be done by rasping it into fine particles and cementing these together into a solid form with either boiled linseed oil or a little new rubber solution. Once vulcanised, rubber is proof against all known solvents ; many will soften and cause it to swell up in size, but none will bring it back to a workable form ; and although thousands of attempts have been made to bring it back into the same condition as before the heating with sulphur took place, they have all failed. Buyers of rubber articles will have noticed a big difference in the durability between low-priced, not cheap, goods and the standard makes, which is easily accounted for by the following facts. An unscrupulous manufacturer will buy up old scrap, say, at 2½d. per pound, grind it up and mix it intimately with oxidised linseed oil, or make a better quality by substituting a small portion of new rubber for the oil. This gives him a material which he is able to put on the market much below the price of the genuine stuff, leaving him in addition a very handsome profit. Provided the shoddy rubber and the binding material are both of the same quality of rubber, chemical analysis will not detect the fake ; the only test is by actual wear, in which the difference is very speedily found. The reason why remanufactured rubber will not stand hard wear is the lack of coherence between the particles of old material, these being only held together by the merest film of new rubber, so that, instead of being a tough, homogeneous substance like new rubber, it consists of particles which readily crumble and break away. When such a binding substance as linseed oil is used, the strength is much less than rubber solution, and, owing to this oil setting into a flexible substance very like rubber in appearance, it is a favourite constituent of rubber compositions. For such purposes as door-mats, cheap shoes, rubber heels, toys, etc., the use of the resuscitated material is legitimate ; but when applied to such purposes as rings for the packing of high-pressure steam-pipes, it cannot be so lightly looked upon, since in this case it constitutes a serious danger. Hard vulcanised rubber was formerly much used for insulating purposes in electrical trades, and for such purposes many of the compositions made from old or reclaimed rubber are quite effective enough, provided they do not deteriorate with time and lose their insulating property. At the present day, however, rubber for electrical purposes has been largely replaced by paper, cotton, mica, glass, etc., so that its importance to this industry has grown very much less.

Like water, rubber is " incompressible "—that is to say, its form is readily modified by pressing or pulling—but the actual bulk remains the same, and if compressed in one direction it expands equally in another. Oil or grease of any kind is a deadly enemy to rubber, which softens under its action and quickly loses its elasticity and strength. Sunlight is also destructive to it, and sets up a gradual decomposition which nothing can prevent ; in fact rubber articles of every kind seem to undergo a slow change in their composition, becoming more brittle with age, and with mackintoshes the protective layers become friable and fall away. Immersion under water is the best preservative for rubber, and, as most people are aware, one day's exposure to sunlight works more mischief with a rubber-proofed garment than three months' wear in wet weather. What the chemical compound of sulphur and raw rubber is no one as yet knows ; but once vulcanised the sulphur is held tenaciously, so that it cannot be eliminated by any of the agents so far available, and the reactions between the two seem to be deep-seated and difficult to follow. A fortune awaits the man lucky enough to invent a method of reclaiming old rubber or to find a substitute having all the properties of natural caoutchouc. This field of research has engaged the intellects of many distinguished chemists in the past, and is still doing so to-day. Some time ago a patent for obtaining a rubber-like body from cereals was brought out ; this was based upon the chewing of corn into a sticky gum which many of us are familiar with as children, and the process was very similar to that of mastication—namely, washing away all the starchy granules until nothing was left but a grey glutinous substance. This, like many other ideas, does not appear to have met with success, as nothing further has been heard about it. Substitutes for rubber have been exemplified for years in the case of the composition used for printers' rollers; this used to be a mixture of glue and treacle which sets into an elastic, rubber-like substance; to-day the treacle has been replaced by glycerine, but the properties of the composition are much the same. Rubber, one way or another, accompanies man throughout his earthly pilgrimage. As an infant his soother is composed of it; later on, if successful, the tyres of his motor are shod with it; and by means of a vulcanite pen he signs his cheques and other papers with it; while after nature has failed him, the foundation of his latest teeth is ubiquitous rubber.

Reviews of Books

Aviation. By B. M. CARMINA. (The Macmillan Company, 11*s.* net.)

The author, who is Assistant Chief Instructor at the Y.M.C.A. Airplane Mechanics School, discusses the subject both from a theoretical and a practical point of view, and his book should prove of special interest to those engaged in the construction, maintenance, or designing of aeroplanes. The book, which is copiously illustrated, deals very fully with the practical side of the question; and the index will make it valuable as a work of reference. Mr. Carmina writes best when he is giving information which has been obtained as the result of experience, such as the reasons for the choice of the various materials used, the advantages of the tractor type over the pusher, the value of giving curved surfaces to the wings, etc. His use of phrases like "horizontal and vertical stabilisers for tail and fin," although somewhat cumbrous, tends to make his work clearer; the study of aviation has been made in the past needlessly confusing by using misleading terms, e.g. planes for wings. The author is less happy when dealing with the theoretical side of the subject, partly perhaps because he has attempted the impossible task of giving explanations of a scientific nature suitable to non-scientific readers. This perhaps accounts for loose statements like (p. 12) "what we would gain in lift we would lose in weight"; and for the error in his definition of centre of pressure (p. 10), though this, in view of the fact that it is correctly defined on p. 152, may be due to carelessness.

The book is excellently printed, and the only misprint, which might give rise to confusion, is on p. 157, where the metre is stated to be 30·37 inches, nine inches too short.

T. B. M. S.

The Geography of Plants. By M. E. HARDY, D.Sc. (Clarendon Press, 7*s.* 6*d.* net.)

Seven years ago Dr. Hardy's *Introduction to Plant Geography* was published. This new book of his is a more ambitious and a more advanced work on the same

Continued on p. 190

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subject. It contains a full description and discussion of the conditions in which plants flourish, and of their distribution in the geographical divisions of the earth. The book is well illustrated, and should be widely appreciated by all who teach or study geography, or have an interest in economic botany.

(*a*) *The Analysis of Minerals and Ores of the Rarer Elements.* By W. R. SCHOELLER, Ph.D., and A. R. POWELL. (Charles Griffin, 18*s.* net.)

(*b*) *The Mineralogy of the Rarer Metals.* By E. CAHEN and (the late) W. O. WOOTTON. (Charles Griffin, 10*s.* 6*d.* net.)

(*a*) There is need at the present time for a book which deals systematically with the complete analysis of ores and compounds containing the rarer elements. Many of these rarer elements are now so important industrially that it is time the general chemist was acquainted with a subject which in this country at least has been pursued by a few men only.

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(*b*) The sub-title is a "Handbook for Prospectors," and the book is beautifully bound in leather like a presentation "Kipling." It is, unlike many books for prospectors produced in America, scientific through and through, and we imagine it will sell best to, and be appreciated most by, the class of reader which is interested in the book (*a*). This book describes the minerals of the forty elements which are classed as rare. Under each metal is given a description of its properties, its metallurgy, its industrial application; then follows a list of its ores, those of commercial importance being specially mentioned. The methods of detecting the elements in ores by analysis are next given. Each ore is described in detail, its occurrence, appearance, colour, crystalline form, etc.

The information is up-to-date, and the book is a useful and indispensable compilation.

We commend both these books. They are unique in English. A. S. R.

Man Past and Present. By A. H. KEANE. Revised and largely re-written by A. HINGSTON QUIGGIN and A. C. HADDON. (Cambridge University Press, 1920, 36*s.* net.)

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A family album of sixteen plates—with nearly a hundred human portraits—forms a useful and appropriate conclusion. P. C. P.

Invertebrate Palæontology. By H. L. HAWKINS. (Methuen, 6*s.* 6*d.* net.)

This book is an introduction to the study of fossils, and is written by the Lecturer in Geology at University College, Reading. In the first part of the book the author explains what palæontology really is, and why it is that students of it can be keen and even enthusiastic about it. Thereafter he goes on to describe the sequence of evolution as it has been unfolded in geological time. The book is well illustrated by photographs and drawings made by the author. These and the particularly lucid style of the author greatly assist to make a difficult subject clear. The book is primarily written for those who have an acquaintance with geology and zoology, and is of university standard.

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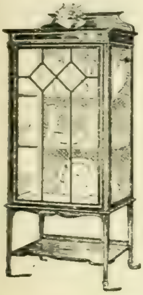

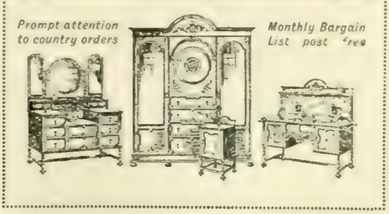

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Editorial Notes

The Oxford University Press General Catalogue for 1920 has been sent me, and the announcement regarding the *Dictionary of National Biography* and the account of the *Oxford Dictionary* will be of interest to readers. The *Dictionary of National Biography* was presented recently to the University by the family of the founder, the late George M. Smith. This, the largest of all national collections of biographies, was designed and the sole responsibility of its production undertaken by the late George M. Smith in 1882. It appeared in sixty-three quarterly volumes from January 1, 1885, to Midsummer 1900: Volumes I–XXI under the editorship of Leslie Stephen, XXII–XXVII under the joint editorship of Mr. Stephen and Mr. Sidney Lee, and XXVII–LXIII (from H to Z) under the sole editorship of Mr. Lee, now Sir Sidney Lee. In order to include notable persons who died during the progress of the work, a Supplement in three volumes (LXIV–LXVI) was published in 1901–2, the date of Queen Victoria's death, January 22, 1901, being taken as its limit. These sixty-six volumes were reprinted, with corrections, on thinner paper in 1908 and 1909 and reissued in twenty-two volumes. The statistical account prefixed to the first volume, and the Memoir of George M. Smith which follows the Preface to Vol. XXII, give particulars of the distribution among the centuries of the lives—more than thirty thousand in number—of the persons commemorated, of the principal contributors to the Dictionary, and of the strenuous life of its Founder, who died on April 6, 1901.

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The Index and Epitome to the Dictionary and First Supplement was designed by Mr. Smith, in consultation with Sir Sidney Lee, as a "summary guide" in the use of the Dictionary and its Supplement, and published in 1903. Containing, as it does, exact names and dates with other details sufficient for identification, it supplies the quickest possible means of finding the article required, whenever the full name or designation of a person is not known beforehand. But as all the articles of the Dictionary without exception appear in it in abridged form, it is in itself within the compass of its two thousand pages a complete biographical dictionary, from which the main facts and dates of a man's life may be ascertained, so that it is an excellent addition to the smaller libraries for which the Dictionary itself is too large. The Index and Epitome to the Second Supplement (1913) is bound in with that of the Dictionary and Supplement.

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The "Second Supplement" was undertaken by Mrs. George M. Smith, edited by Sir Sidney Lee, and published in three volumes 1912–13. It contains biographies, 1660 in number, of noteworthy persons who died between January 22, 1901, and December 31, 1911. It has during the war been out of print, but is now being reprinted in one volume, and will be ready shortly.

Preliminary work is now being carried out under the direction of Mr. H. W. Carless Davis, with a view to maintaining and extending the usefulness of the Dictionary.

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The following account of the history of the great *Oxford Dictionary* is taken from the Catalogue. The collection of the materials which are used in the preparation of the *Oxford Dictionary* began in 1857 with the appointment, by the Philological Society in London, of a committee for the collection of words unregistered in existing dictionaries. Dr. Trench, then Dean of Westminster, read before the Society two papers in which, " while speaking with much appreciation of the labours of Dr. Johnson and his successors, he declared that these labours yet fell far short of giving us the ideal English Dictionary. Especially, he pointed out that for the *history* of words and families of words, and for the changes of form and sense which words had historically passed through, they gave hardly any help whatever. No one could find out from all the dictionaries extant how long any particular word had been in the language, which of the many senses in which many words were used was the original, or how or when these many senses had been developed ; nor, in the case of words described as *obsolete*, were we told *when* they became obsolete or by whom they were last used. He pointed out also that the obsolete and the rarer words of the language had never been completely collected ; that thousands of words current in the literature of the past three centuries had escaped the diligence of Johnson and all his supplementers ; that, indeed, the collection of the requisite material for a complete dictionary could not be compassed by any one man, however long-lived and however diligent, but must be the work of many collaborators who would undertake systematically to read and to extract English literature. He called upon the Philological Society, therefore, as the only body in England then interesting itself in the language, to undertake the collection of materials to complete the work already done by Bailey, Johnson, Todd, Webster, Richardson, and others, and to prepare a supplement to all the dictionaries, which should register all omitted words and senses, and supply all the historical information in which these works were lacking, and, above all, should give quotations illustrating the first and last appearance, and every notable point in the life-history of every word."

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The collection of materials for the supplement was at once begun by the Committee and seventy-six volunteers, but it soon became apparent that the projected supplement would be greater than all the existing dictionaries. Accordingly plans were discussed for a *New English Dictionary*, and Mr. Herbert Coleridge was appointed editor. Under his direction rules were issued for the guidance of volunteer readers, some hundreds of books were read or undertaken to be read, and the editor himself published his Glossarial Index to the printed literature of the thirteenth century. He had prepared lists of words from A to D, and had put into type specimen pages containing articles upon some early words, shortly before his lamented death, in 1861. He had calculated that, when he had one hundred thousand illustrative quotations in his pigeon-holes, it would be time to begin making the Dictionary.

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Dr. Furnivall, who was next appointed editor, " realised much more fully the immensity of the work." He pressed on the collection of quotations, divided the letters of the alphabet among volunteer sub-editors, each of whom, it was hoped, would arrange the quotations supplied of words beginning with the letter entrusted to him, classify the different senses of each word, and so leave to the editor only the final redaction of the articles. And, becoming conscious of the great bulk of our early literature which had not been printed, or had been very imperfectly printed, Furnivall founded in 1864 the Early English Text Society, which from that time until now has been engaged in the accurate reproduction of those early writings without which no historical knowledge of English language and literature is possible.

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The work thus begun was continued for many years, but could not be brought to completion. The materials accumulated as more books were read, but experience showed that it was impossible for volunteer workers to bring them into a single plan : in the absence of an editor and a staff giving their whole time to the work, gaps in the material could not be discovered or filled, and an attempt made by Furnivall to construct a *Concise Dictionary*, which should show what had been done and what remained to do, broke down after many years of effort. The first enthusiasm of the workers waned when it was found that printing was so far distant ; the London and American publishers who were consulted were unable to undertake a work of the magnitude which it was clear would be necessary, and the whole undertaking languished.

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The collections which had been made were too valuable to be abandoned, and in 1878 it was suggested that the Philological Society should invite the co-operation of the Clarendon Press. Negotiations between the Society, the Press, and Dr. Murray, who was by common consent designated as the editor, were entered into, and agreements were drawn up which were finally settled early in 1879. Even at this time the immensity of the work was not fully realised. The Dictionary, it was thought, " would occupy not less than 6,000 and not more than 7,000 pages," and it could be completed, it was assumed, in ten years by a single editor, with a small staff. But when Dr. Murray, in 1879, began his work, " careful examination of the quotations, then for the first time collected in one place and arranged in a continuous alphabetical series, showed that much work still remained to be done in order to render the material adequate for the purpose. Accordingly a new appeal was made to volunteers to collect additional quotations from specified books, of which lists were from time to time issued. More than eight hundred readers in Great Britain, the United States, and elsewhere, responded to this appeal, and in the course of three years a million additional quotations were furnished, raising the total number to three and a half millions, selected by about thirteen hundred readers, from the works of more than five thousand authors of all periods. About thirty sub-editors (including a few who have never ceased to work for the Dictionary) offered their gratuitous services in arranging quotations, preparing definitions, and otherwise contributing to the progress of the work. Without the aid of these generous contributors and fellow-labourers so great a task could never have been undertaken."

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These immense collections, which even before the printing of the work had begun were already thirty-five times larger than had been contemplated in 1860, would have been sufficient in themselves to ensure the supereminence of the Dictionary. No other book has had, and very few ever will have, foundations laid in an inductive investigation of so wide a character. A simple classification of the available material for the various words, an intelligent selection from it, and a careful verification of the references, would have resulted in producing a work of the greatest value and usefulness. The adoption of such a course, however, which in itself would have involved no small amount of labour, was rendered virtually impossible by the very wealth of the material. This continually raised problems and presented difficulties which had not confronted any previous lexicographer, and the solution of these constantly involved prolonged researches in many different fields of study. A single quotation, containing a rare word or some unusual sense of a word, frequently became the starting-point of an investigation, historical or etymological, which might lead to some interesting discovery and explain something previously unknown or misunderstood. At an early stage of the work it became apparent that such researches, if they were to be adequately carried out, would demand ample limits of time and space, and that satisfactory results could only be achieved by the organisation of a large and highly skilled editorial staff, which could have easy access to one or other of the great libraries, and profit by the assistance of many scholars and men of science. To attain this end, Dr. Murray with his staff removed to Oxford in 1885. He was fortunate in the widespread interest which his work excited in this and other countries, and in the many lasting friendships which it made for him. Without the generous help which this interest and these friendships drew from many quarters, it would have been almost impossible to collect adequate materials for the Dictionary. The list of voluntary helpers within the British Islands, many of whom have rendered inestimable service, is so extensive that it must be sought in the prefaces to the various volumes; but something may be said here of the assistance which has come from over the seas. In early stages much help was given by American scholars, whose work was organised and superintended by Professor F. A. March, of Lafayette College, Penn. The preface to Vol. I (p. 15) records large contributions of materials from several Americans, while here, or in other volumes, the names of Fitzedward Hall, W. C. Minor, A. Matthews, C. W. Ernst, etc., are mentioned among those to whom special recognition is due. In another direction, across the North Sea, Mr. Caland, of Wageningen, was for many years a devoted contributor and critical proof-reader.

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Even with all the assistance thus freely given, it became evident, within a few years from the start, that the magnitude of the task undertaken by Sir James Murray had not been fully realised. To hasten the completion of the work, additional editors were appointed.

Dr. Bradley, who had previously worked in London, first giving help with the letter B, undertook the editing of E, and removed to Oxford in 1896. Dr. Craigie, who joined the staff at Oxford in 1897, first assisted in the preparation of G, I, and K, and began independent editing with Q. Mr. Onions, after completing ten years of service with Sir James Murray and Dr. Bradley, was engaged in specially preparing portions of M, N, R, and S, and at the beginning of 1914 undertook the independent editing of Su-Sz.

Thus the editorial list stands at October 1, 1919:

> The late Sir James Murray, editor of A B C D, H I J K, O P, T.
> Henry Bradley, editor of E F G, L M, S–Sh, and St.
> William A. Craigie, editor of N, Q R, Si–Sq, and V.
> C. T. Onions, editor of Su-Sz.

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Sir James Murray died on July 26, 1915. His great wish that he should live to finish the Dictionary on his eightieth birthday, in 1917, had not been fulfilled; the unceasing labour of three-and-thirty years ended when less than a tenth part of the work remained to be done. Almost within a week of his death he was still spending long hours at his desk. At the beginning he laid the lines and drew the plan; in the prosecution shared, his amazing capacity for unremitting labour enabled him to take more than an equal part, and the volumes produced by himself show characteristic excellences which cannot be exactly matched, though they may be rivalled by merits of another kind. "He will not write the last pages, but more than that of any other man his name will be associated with the long and efficient working of the great engine of research by which the Dictionary has been produced."

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Including the work of all the editors, the state of the *Oxford Dictionary* in 1919 is as follows. Nine of the ten volumes are complete, and, with the portions of the tenth volume already published, carry the vocabulary without a break from A to THYZLE. V is completed, and only one section of it remains to be published. Most of U is practically ready for the printer and the earlier part is in type. X and the beginning of W and of Y are also in type. On October 1, 1919, the Dictionary extends to 14,080 pages and deals with 376,624 words, illustrated by 1,642,057 quotations.

This completion of the third half-million of quotations contrasts with the original calculations of Mr. Coleridge, that it would be time to begin the making of the Dictionary when one hundred thousand quotations were available.

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The seventh volume, containing the words beginning with the letters O and P, contains more words than any of the volumes published so far. The total is 48,870 words—30,300 main words, 6,393 subordinate words, 4,974 special combinations, and 7,203 obvious combinations. Of the main words, 23,120 are described as current, 5,335 as obsolete, and 1,845 as alien. As against the Oxford total of 48,870, no other English dictionary contains more than 27,097. No fewer than 38,365 words in the Oxford volume are illustrated by quotations—no other English dictionary has more than 8,368 words, roughly 30,000 fewer, illustrated by quotations, and the illustrative quotations themselves number 175,130 in the Oxford book, or 154,790 more than in any other comparable volume. Johnson's dictionary contained 4,485 words beginning with O and P, of which 3,661 were illustrated by quotations, the quotations numbering 12,111.

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The number of years which have been required to bring the *Oxford Dictionary* to this point will not seem excessive, when it is compared with three foreign dictionaries which in respect of plan and extent may fairly be said to rival it. These are the *Deutsches Wörterbuch*, begun by the brothers Jacob and Wilhelm Grimm, the *Woordenboek der nederlandsche Taal*, begun *språket* of the Swedish Academy. A summary of the past progress and present state of these works affords interesting evidence of the time which is normally spent in the production of dictionaries of this kind.

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The preparatory work for the *Deutsches Wörterbuch* was begun by the brothers Grimm in 1838, but the printing did not commence till the very end of 1851; the first volume, containing A–BIERMOLKE, was completed in 1854. Wilhelm Grimm, who died in 1859, did only the letter D, which forms part of the second volume; Jacob completed the third volume in 1862, and had advanced some way into the fourth at the time of his death, in 1863. Since that date the work has been carried on by various scholars, some twenty in all, eight of whom are specially mentioned in some forms of the general title-page as it appears on the covers of the separate parts. During these fifty-six years the dictionary has progressed from F to an advanced point in S, though part of G still remains to be done. The rest of the alphabet is represented chiefly by continuous portions of T, V, and W, with smaller unconnected sections of S, U, V, W, and Z; most of these minor sections have been produced within recent years, as the result of a special effort to complete the work. With the exception of Vol. IV (which is immensely out of proportion to the others), the first nine volumes and the first part of Vol. X are finished, and carry the work as far as STEIFEN. The second part of Vol. X is also well advanced, and considerable progress has been made with four of the six remaining volumes. The total result of sixty-seven years of printing and publishing amounts to 20,554 pages (equivalent to rather more than 10,000 pages of the *Oxford Dictionary*), and covers about five-sixths of the whole German vocabulary.

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The beginnings of the Dutch dictionary date from 1850–51, and by 1852 the two original editors, De Vries and Te Winkel, had started the systematic collection of materials for the work. It was not, however, till 1864 that the first part made its appearance. After the death of Te Winkel, in 1868, De Vries continued the work with various colleagues until his own death in 1892; since that date the dictionary has been carried on by some of these colleagues and by other editors subsequently appointed. After fifty-five years of publication, the present state of the *Woordenboek* is as follows: Vols. I–VI, containing A to I, are complete with the exception of the latter part of Vol. III, and Vols. IX and X, containing M, N, and part of O, have also been finished. Of the remainder, Vols. VIII and XI have made considerable progress, while Vols. VII, XII, and XIII are less advanced; the latter, ending at present with RONDVORSCHEN, is the furthest point the dictionary has reached. The portion of the work now published amounts to 14,469 pages (equivalent to less than 6,000 pages of the *Oxford Dictionary*), and contains about three-fifths of the Dutch vocabulary.

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The dictionary of the Swedish Academy is much less advanced than either of the above. The first part appeared in 1893, and up to the present time four complete volumes have been published, with portions of another two. These, however, contain only the letters A, B (incomplete), C, and D (incomplete); five-sixths of the Swedish vocabulary still remain to be dealt with.

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In order to make the *Oxford Dictionary* accessible to scholars and students, it is published at a price which is at least as low as that for any printed matter in book form. The price of a single section of 64 pages is only 2*s*. 6*d*. net, or less than one halfpenny a page. The entire work, so far as it has gone—the first nine volumes bound in half-morocco, and the sections of Vol. X in paper boards—can be purchased for £35 4*s*. 6*d*. net.

Recent Work on Heredity

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(1) THE CHROMOSOMES AS THE PHYSICAL BASIS OF HEREDITY

THE latest advance in general biology has been the discovery that inheritance takes place by means of separable units, generally known as unit-factors or *genes*. It is effecting the same sort of revolution in our biological thinking that Dalton's realisation of atoms as the units composing chemical substances did for chemical thinking a hundred years ago.

But before we can grasp the meaning of this change, we must go over some well-known facts of biology that have been brought to light by microscopical observation. Practically the whole of these facts have been discovered in the last fifty years. Much of the earlier work, especially on the meaning of the observations, was done by Germans, prominent among whom were Flemming, Weismann the great evolutionist, Boveri, and the botanist Strasburger. In later years, England has produced well-known workers in this field in the persons of Doncaster and Farmer, and America in E. B. Wilson. The facts, as we understand them to-day, are briefly as follows:

All higher plants as well as higher animals, when their tissues are examined under the microscope, are seen to be composed of visible units called cells. Each cell consists of a mass of living substance, the cytoplasm, in which is embedded a central denser body, also alive, the nucleus. Although the number of cells in the body of a man is to be reckoned not by millions, but by millions of millions, they are all formed during development from one single original cell, the fertilised ovum. This starts by dividing into two equal halves, then into four, and so on, growth keeping pace with cell-division. When a cell divides, its cytoplasm is simply split into two roughly equal parts. The division of the nucleus is, however, a more elaborate matter. The essential substance condenses to produce a definite number of little threads or rods, which take up many dyes, and are hence called chromosomes, or coloured bodies. Every species of animal and plant has a characteristic number of chromosomes, and in any one species this number is found in every cell. At division, each chromosome is split down the middle, so that each single thread gives rise to two new threads. One of these goes into one of the two new cells formed by the division of the old one, the other into the other. If we were to imagine the chromosomes to consist of a series of small units, of pieces of living substance, strung along them like beads of different colours and shape along a string, each one important in some way for life, and each different from every other, then this peculiar method of nuclear division by longitudinal splitting of chromosomes would be an admirable way of ensuring that all these different units should be divided equally at each cell-division. In other words, each of the two cells produced by division will get half of every unit present in the original cell; and these half-units, being composed of living substance, will grow into wholes, so that all the millions of cells in the body will possess a complete set of these units, and one that is identical with the set which was present in the original fertilised ovum.

This fertilised ovum, however, did not arise out of nothing. It was formed by the union of two cells from the two parents. One, the unfertilised ovum, was detached from the ovary of the mother; the other, the spermatozoon, was detached from the reproductive tissue of the father.

Here comes in a remarkable fact with regard to the chromosomes. In any ordinary cell of the body, the number of chromosomes is, speaking generally, an even one. Sometimes the chromosomes of an animal differ in size or shape, and when this is so they can always be arranged in pairs, so that there are apparently two sets of chromosomes, which may be compared to two packs of cards. The ovum and sperm, however, only contain half the ordinary number, and only one of each pair—in other words, one whole set or pack.

This halving of the chromosome-number before the formation of the reproductive cells is a universal occurrence in animals or plants which possess sexual reproduction, and is known as *reduction.* Thus at fertilisation, one complete set of chromosomes derived from the father is united with a second complete set derived from the mother.

When these facts were first discovered, the theory was promptly advanced that it was by means of the chromosomes that inheritance was to be explained. The ovum and sperm differ from each other in almost every particular of size and shape and constitution. There is only one point in which they agree, and in that they are identical: both possess one complete set of chromosomes. It was therefore natural to suppose that it is by means of these chromosomes that organisms—whether plants, animals, or human beings—inherit characters equally easily, as we know they do, from their mother's or their father's side. We shall see later that this theory has been abundantly justified by the facts that have since been discovered.

Meanwhile, let us not think too much of theories, but merely of the established fact that all higher living things possess in every cell of their body two complete sets of chromosomes, one coming from the father, one from the mother, and that each of these is accurately divided every time that a cell divides.

While one set of workers was establishing these facts, others were engaged on extensive plant- and animal-breeding experiments, with results which will be the subject of the next section.

(2) Breeding Experiments and the Idea of Unit-Factors

The other line of attack on the problem of heredity has, of course, been by breeding experiments. Enormous numbers of crosses between different varieties both of animals and plants were carried out during last century, and a number of general conclusions arrived at. But there remained a feeling that we had only scratched the skin of the problem, without any real penetration of its hidden secrets. Then, in 1900, a dramatic event in scientific history took place. Two independent workers, reading through the literature on the subject in the hope of hitting on something to illuminate their results, happened upon an account of some experiments carried out and recorded as far back as 1866 by an Austrian monk, Gregor Mendel, Abbot of Brünn. These had lain unproductive for half a century, like seed in a box. Now at last they were to germinate. Both men realised their importance; they have served as the basis of all the enormous advance that has since been made; and there has sprung into being a new science, of animal- and plant-breeding carried out on the Abbot's principles, and called Mendelism in his honour.

What were the new principles that proved so illuminating? Put as briefly as possible, they are as follows: Wherever one variety of an animal differs from another variety in a constant and well-marked way, these differences can be shown, by cross-breeding experiments, to depend on a definite number of separate characters which can be passed on from parent to offspring—in other words inherited—and each of which can, by proper crosses, be separated from the others. An example will make this clear. There are two races of fowls, the one black, the other white with black splashes. When crossed together, all their offspring in the first, or, as it is often called, the F1 generation, are alike; but they do not resemble either parent. This form of fowl is bluish-black with black lacing, and is called the Blue Andalusian. If these Andalusians are bred together, the next, or F2, generation will consist of three different sorts of fowls—white exactly like their white grandparents, black exactly like their black grandparents, and Andalusian exactly like their parents. These will always appear, if a sufficient number is bred, in the same proportion, the whites averaging 25 per cent., the Andalusians 50 per cent., and the blacks 25 per cent. Mendel, as a matter of fact, worked not with fowls, but with different strains of peas, but got precisely similar results. The explanation he gave was that something which made the black fowls black was present in their reproductive cells, and so handed to their offspring; while in white fowls, a slightly different something was handed on in the same way. These "somethings" may be called *factors*, and the appearances they produce in the adult fowl *characters.* When whites are crossed with blacks, the fertilised egg receives one white-producing and one black-producing factor. The resulting character is neither black nor white, but a compromise, the bluish colour of the Andalusian. When the Andalusian fowls come to reproduce, the Mendelian theory supposes that all the reproductive cells will receive either a black-producing or a white-producing factor, *but not both.*

Let us for convenience call the former B and the latter *b*. There are, then, four possibilities for the next generation. A sperm with B can equally well fertilise an ovum with B or one with *b*; and the same two possibilities are open to sperms containing *b*, and each of these unions is equally likely to occur. Thus on the average, out of every large lot of resulting fowls, one-quarter will contain $B + B$, one-half $B + b$, and the last quarter $b + b$. But $B + B$ will give a black fowl, $B + b$ an Andalusian, and $b + b$ a white. We thus have an explanation both for the sort of fowls produced in the F1 generation, and of the

Cross.	Parents.			Fertilisation.	Offspring.		
	Appearance.	Factors.	Reproductive Cells.		Factors.	Appearance.	
Fowls, black × splashed white (1st generation)	Black	BB	All B	B + *b*	B*b*	All Andalusian (= F1)	
	White	*bb*	All *b*				
Fowls, black × splashed white (2nd generation)	F1 Andalusian	B*b*	50% B 50% *b*	B + B	BB	Black (25%)	(= F2).
				B + *b*	B*b*	Andalusian (50%)	
	F1 Andalusian	B*b*	50% B 50% *b*	B + *b*	B*b*		
				b + *b*	*bb*	White (25%)	

proportions in which the different sorts occur. In subsequent generations the F2 whites will breed true like the original pure white strain, the blacks breed true like the original black, and the Andalusians will give the same results as their F1 Andalusian parents.

Another character in which breeds of fowls may differ is the shape and size of the comb. If two breeds, one with the ordinary high comb (so-called single comb), the other with a rose comb (a low comb with little warts on it), are crossed, we shall get results precisely similar to those found in the Andalusian fowl. The second, or F2, generation will consist of 25 per cent. of birds which will breed true to single-comb shape, 25 per cent. which will breed true to rose-comb shape, and 50 per cent. which will contain one factor for each of the two comb-shapes, and therefore will not breed true.

The question immediately arises, What will happen if a white bird with a single comb is crossed with a black bird with a rose comb? Will the white colour and single-comb shape stick together, or shall we be able to separate and recombine them? The answer given by experiment is that recombination is possible. In the F2 generation, we shall get two new pure-breeding types—white birds with rose combs, and black birds with single combs—as well as types like the original parents, and types that do not breed true.

Similar results have been obtained by the hundreds of thousands of crosses which have been made during the last twenty years with Mendel's principle in mind, and we can assert, without any fear of contradiction, that for the majority of characters which go to make up any species or race of animal or plant, and to mark it off from other species, the fundamental laws laid down by Mendel hold good.

To be brief, we may say, first, that all the characters of a species are controlled in their development by definite units or factors, which can be handed on from parent to offspring. Secondly, that all such factors are present in pairs, one being derived from the father, the other from the mother. Thirdly, that when the reproductive cells are formed the two members of a pair separate from each other, so that each sperm or each ovum must contain one member of a pair, but cannot contain both; and, finally, that different unit-factors are inherited independently of each other, so that, by making the right series of crosses, we can build up new races or varieties of animals by combining factors for characters of different existing breeds. All kinds of characters have been shown to be inherited by means of unit-factors—colour, shape, size, fertility, vigour, resistance to disease, abnormality, length of life. The external environment may often modify the way in which a character develops; but the basis which can be modified at all, and the limits of the extent to which it can be modified, are provided by the factor and its influence during development.

Through Mendel, the idea of the unit-factor was introduced into the study of inheritance. By the labour of innumerable workers, some of the best-known of whom are Bateson and Punnett in England, Baur

Cross.	Parents.			Fertilisation.	Offspring.	
	Appearance.	Factors.	Reproductive Cells.		Factors.	Appearance.
Fowls, black and rose comb × splashed white and single comb (1st generation)	Black, rose	BB . RR	All B . R	B . R + *b* . *r*	B*b* . R*r*	Andalusian, rose (= F1).
	White, single	*bb* . *rr*	All *b* . *r*			
Ditto (2nd generation)	F1 Andalusian, rose	B*b* . R*r*	25% B . R 25% B . *r* 25% *b* . R 25% *b* . *r*			
	F1 Andalusian, rose	B*b* . R*r*	25% B . R 25% B . *r* 25% *b* . R 25% *b* . *r*			

Thus, besides combinations which will not breed true, we shall get BR + BR = pure for black and rose, like one grandparent; *b* . *r* + *b* . *r* = pure for white and single, like the other grandparent; and also B . *r* + B . *r* = pure for black and single; and *b* . R + *b* . R = pure for white and rose—i.e. two new pure-breeding strains.

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[1] These fowls appear with a rose comb, as rose is what is called *dominant* to single; i.e. rose appears even when only one R is present. R*r* birds, therefore, *appear* rose-combed, but do not breed true for comb-shape.

in Germany, De Vries in Holland, and Morgan in America, his principles have been shown to hold good for every sort and kind of characters, in every sort and kind of organism, including man himself.

In the next section we shall see how the most recent work is combining the facts drawn from a study of the chromosomes with those connected with inheritance by unit-factors.

(3) THE CHROMOSOMES AS THE BEARERS OF THE UNIT-FACTORS

In our first two sections we were dealing with facts and principles which, though once the subject of heated dispute, are now accepted as proven by all biologists. In the present one, we are touching on discoveries so recent as to be still in the region of controversy. The principles here set forth, however, though still not accepted by many men of science, are rapidly gaining ground, and are being used as a basis by the majority of research workers in heredity. The writer believes them to be true in all essentials, and certainly to be far better as a working hypothesis to guide our future advance than any others now in the field, and therefore offers no apology for presenting them in a popular article.

In our study of unit-factors, we saw that one of Mendel's laws asserted that unit-factors were inherited independently of each other. This was the original form of the law, and is true for many factors. But as animals were bred on a large scale, and single species were worked on in an intensive way, to study the relation of a great many separate factors to each other, exceptions were found which have made it necessary to restate the law. In its new form, it runs as follows: (1) Unit-factors are inherited in groups. (2) These groups of factors are not inherited entirely *en bloc*, but, though the factors within each group are linked together, the linkage is not absolute. In other words, the factors of one group tend to be linked together in inheritance; but the linkage is not complete, and is of various intensities for different factors. (3) The number of groups is constant for any particular species.

Into the details of the second of the three points we will not now enter. It is the fact that a constant number of independent groups of factors do exist (and this is undoubted) which interests us for the moment.

It will be remembered that observation with the microscope revealed the fact that a constant number of chromosomes was also present in each species. It is, therefore, a natural question to ask whether there is any relation between the number of groups and the number of chromosomes. So far, on account of the enormous amount of time and labour involved in carrying out the requisite number of breeding experiments, the question has only been actually answered for one species, though researches with the same end in view are in progress on many animals and plants. The one form where a definite answer has been obtained is a tiny fly called Drosophila. This is particularly suitable for breeding experiments, as it can be easily kept; it has large broods of offspring, and a new generation appears about once a fortnight. Morgan and his fellow-workers have now records of about half a million of these flies, all with known pedigree. To obtain a record of the same number of generations in man, we should have to go back before the dawn of history. Something like two hundred variations, or *mutations*, have cropped up spontaneously in his stock, and the inheritance of most of these has been worked out. The result has been to show that there are four groups of factors, which is the same number as the number of pairs of chromosomes. Further, the number of factors so far found in each group is roughly proportional to the length of the different chromosomes as seen under the microscope. Morgan and many others, therefore, conclude that the physical basis for the unit-factors is to be found in the chromosomes. If one single factor were to be found not linked to any of the four existing groups, the whole theory would have to be given up, as it would be impossible to reconcile five factor-groups with four pairs of chromosomes.

Other facts (connected with linkage) indicate strongly that the unit-factors are arranged in a row along the chromosomes, like beads on a necklace. In this, therefore, we have an explanation of the facts observed in the division of chromosomes (see the first section).

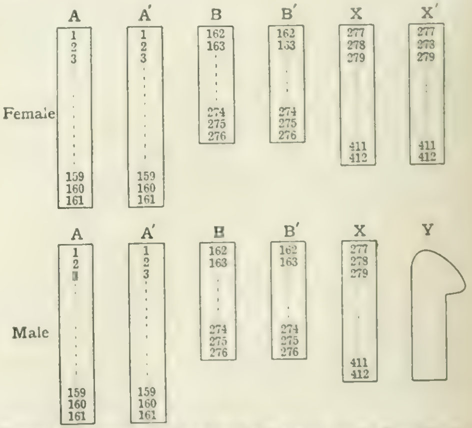

Diagram of the chromosomes in a species with 3 pairs, showing linear arrangement of unit-factors, and difference of chromosomes between the sexes (see article next month).

It is, therefore, extremely probable that there are a great number—probably thousands in the higher animals—of unit-factors arranged in two single rows or series inside the nucleus; that this series is cut up into what we see and call the chromosomes, for the sake of convenience of handling at cell-division, etc.; and that the presence of one series—in other words, of one set of unit-factors—is necessary for development to occur and for characters to be handed on from parent to offspring. A glance at the diagram on the previous page will make the general principle clear.

It will be seen that the observed fact of the chromosomes being present in pairs fits with the fact of unit-factors being present in pairs, and that the reduction of the chromosomes explains how only one of each pair of unit-factors is present in any of the reproductive cells.

If the reader has had the patience to follow the discussion till now, he will see that a new way of looking at animals and plants is opened to our intellect. We must think of them, in the first place, as being produced by the interaction of a great number of separate particles of living substance, the factors, each one a separate unit in the original fertilised egg, and each one capable of undergoing lasting alteration (mutating) quite independently of the rest. Secondly, we must think of ourselves and other organisms as being essentially double, with a complete set of these units from father and mother alike. Thirdly, since these units can be inherited more or less independently of each other, sexual reproduction means first a reshuffling of the factors, and then a recombination of them in new arrangements. In other words, if a useful variation in one detail has occurred in one animal, and one in another point has occurred in another, sexual reproduction gives the opportunity for these two separate useful characters to be combined in a single breed. In passing, it may be remarked that this is probably the reason for the almost universal occurrence of sexual reproduction both in animals and plants. Fourthly, we know that these mutations in single factors are constantly happening. At present we do not know how to produce mutations; but the belief that we shall eventually be able to do so underlies our work, and once we have discovered the way, our knowledge of the laws of heredity will enable us to build up improved races of animals and plants as easily as the chemist now builds up every sort and kind of substance in his laboratory. In a word, Mendelism made it possible for us to represent the hereditary composition of an organism by a *formula*. More recent work is making it possible to represent that composition by a *structural formula*.

In the next section, we shall consider the inheritance of sex.

(*For Books of Reference, see p.* 209.)

The Change in the Legal Status of Women

By C. E. A. Bedwell

Hon. Secretary of the Society of Comparative Legislation

On December 23, 1919, "An Act to amend the Law with respect to disqualifications on account of sex" received the Royal Assent. The operative section enacted that "a person shall not be disqualified by sex or marriage from the exercise of any public function, or from being appointed to or holding any civil or judicial office or post, or from entering or assuming or carrying on any civil profession or vocation, or for admission to any incorporated society (whether incorporated by Royal Charter or otherwise), and a person shall not be exempted by sex or marriage from the liability to serve as a juror."

In order to open all occupations and positions to women the Act (1) reverses what had been regarded as the immemorial tradition embodied in the common law of the country, (2) repeals any statutory enactments which limited specific offices to men, and (3) removes any barriers erected either by tradition or prejudice against the admission of women to certain professions and organisations. The chief exclusion now remaining is a disqualification of peeresses sitting and voting in the House of Lords.

The position given to women by the common law of the country is mainly a matter of history. Although examples may be found here and there of women occupying such positions as Sheriff or Lady of the Manor, the result of historical inquiry is that "in the Middle Ages women had in fact no civic position and did not participate in person in local administration. However, they were not debarred from serving as churchwardens, and in this way other duties devolved upon them. In the sixteenth century, when the State used the officers of the ecclesiastical parish for the discharge of civil functions, the woman churchwarden became bound to act as the coadjutor of the overseer; no legislation was passed to relieve women who were 'substantial householders' from filling the office of overseer, though according to custom they might serve by deputy."[1]

The legal effect of the historical evidence was summed up by Lord Esher in a well-known judgment (*Beresford-Hope* v. *Lady Sandhurst* (1889), 23 Q.B.D. at p. 95) "that by neither the common law nor the constitution of this country from the beginning of the common law until now can a woman be entitled to exercise any public function." Mr. Justice Willes, in an earlier case dealing with a woman's right to vote, observed "that the absence of such right is referable to the fact that in this country, in modern times, chiefly out of respect to women, and a sense of decorum, and not from their want of intellect, or their being for any other such reason unfit to take part in the government of the country, they have been excused from taking any share in this department of public affairs" (*Chorlton* v. *Lings* (1868), L.R. 4 C.P. at p. 392). In the eyes of the common law a definite distinction was drawn between public activities in any sphere and the domestic avocations of women. Lord Ronan, on the petition of Georgina Frost to be admitted to the office of Clerk to the Petty Sessions, drew a further distinction between (*a*) a judicial and (*b*) a public office ([1919] 1 Ir. R. at p. 100). This has been adopted by a learned American writer, who, after examining the catena of decided cases upon the subject in the United Kingdom and the United States, comes to the conclusion (*Harvard Law Review*, December 1919, p. 297): "Most of the cases concern women's eligibility to administrative offices, and it is generally said, even by courts which hold that there is no ineligibility here, that the eligibility does not extend to judicial and legislative offices. Certainly the capacities required by the three classes of office differ; in each, common law eligibility depends upon custom, and, as there is considerably less evidence of women holding offices of the last two classes, the distinction will probably be maintained. As for administrative offices, the tendency of recent years has been to hold women eligible."

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[1] "The Civic Position of Women at Common Law before 1800," by Miss Rose Graham, F.R.Hist.S., *Journ. Comparative Legislation*, vol xvii., at p. 193.

But so far as the United Kingdom is concerned the opening of administrative offices to women had abrogated the common law principle enunciated by Lord Esher. The appointment of Factory Inspector is an example of the manner in which the change has been carried through, although there was no legislative enactment. The Home Secretary being of opinion, according to the Chief Inspector of Factories in his annual report for the year 1893, "that the field for the employment of women, within the limits of their own special capacities and aptitudes, should be as wide and as large as could possibly be made, and that there is no field in which they could be more usefully or fruitfully employed than in looking after the health and the industrial conditions under which their fellow women labour in the factories and workshops," simply appointed two "off his own bat." Another Home Secretary might have adopted the decision in *Beresford-Hope* v. *Lady Sandhurst*, as the Act authorising the appointment of factory inspectors makes no mention of women, just in the same way as the Lord Lieutenant of Ireland refused to confirm Miss Frost's appointment as Clerk of the Petty Sessions (*Georgina Frost* [pauper] v. *The King*, *The Times*, April 28, 1920). Acts of Parliament, judicial decisions, and even the well-established common law of the country give way before common sense supported by public opinion, so that by general consent women have exercised various administrative functions for a number of years. On the other hand, measures like the grant of the suffrage to women can only have effect so far as they are carried into operation by the support of public opinion, expressed by attendance at the polls. Acts passed fifteen years ago by which women were admitted to various public offices still remain almost a dead letter, although women's knowledge and experience are much needed in spheres of local government peculiarly within their province.

There are only ten statutes included in the schedule to the Act of 1919 as being specifically amended by the provision that women will now be eligible for all statutory offices. Four apply only to Ireland and three only to Scotland. The most important of the remainder is the Juries Act, 1870, which embodied the principle of the common law that women were disqualified from serving on juries. Now, however, women possessing the requisite property qualifications must be summoned as jurors. It should be observed that the duty of service to the community in this capacity is obligatory, though a woman may be exempt from service "in respect of any case by reason of the nature of the evidence to be given or of the issues to be tried," or if for medical reasons she is unfit to attend; but having regard to the difficulty in securing jurors she will not readily escape from making her contribution to the administration of justice in the country. These ten statutes, of course, do not exhaust the number which are affected by the new Act, as a large number, like the Irish Act above mentioned relating to Petty Sessions, are not specifically but only constructively limited to men.

The opening of the Civil Service to women is accompanied by the proviso in the Act that "His Majesty may by Order in Council authorise regulations to be made providing for and prescribing the mode of the admission of women to the civil service of His Majesty, and the conditions on which women admitted to that service may be appointed to or continue to hold posts therein, and giving power to reserve to men any branch of or posts in the Civil Service in any of His Majesty's possessions overseas, or in any foreign country."

Although the Civil Service cannot be regarded as one of the close corporations whose doors are opened by the Act, it is probably quite as conservative and bound by prejudice as other bodies who are attacked for possessing those qualities. The provision inserted in the Act without conditions enables the intention to place women on the same footing to be rendered nugatory by administrative action. Before the war the Royal Commission on the Civil Service found that Government Departments had paid little heed to the principle of "equal pay for equal work." They reported "that highly-qualified women inspectors receive, in many cases, salaries little more than one-half of those paid to men inspectors of similar grade employed in the same department." On the other hand, during the war many women with minor qualifications were paid on a much higher scale than men. It is too soon yet to make regulations which can have any permanency, as there are still a large number of women occupying posts obtained at a time when there was neither time nor opportunity to examine with any exactness as to their qualifications for them. Some years must elapse, therefore, before an estimate can be made of the position of women in the Civil Service and the developments which have resulted from the passing of the Act.

For some reason, which is not quite apparent, the opening of the legal profession to women has attracted special attention. The history of the efforts made to enter under the old regulations is brief. In 1903 the Benchers of Gray's Inn declined to admit Miss Bertha Cave. From the decision of the Benchers of an Inn of Court there is only an appeal to a domestic tribunal of the Judges. Miss Cave's appeal was heard by eight Judges, over whom the Lord Chancellor (Lord Herschell) presided, and among them was the Lord Chief Justice (Lord Coleridge). They took the line that there was no precedent for women being called to the English Bar and the tribunal were unwilling to create such a precedent. It is worth while to recall in this connection that Miss Orme, who was the first woman to take the LL.B. at London University, practised for some years in the chambers of eminent conveyancing counsel, but, in anticipation of a refusal, never applied for a certificate to regularise her position as a practitioner in that branch of legal work. In 1913 Miss Bebb, who has now become a member of Lincoln's Inn, sought a declaration from the Court of Chancery that she was a 'person' within the meaning of the Solicitors and Attorneys Act, 1843, and the amending Acts, and that she was entitled to be admitted to the preliminary examination held by the Law Society under such Acts. Some authorities were cited of women having acted as attorneys before the year 1322. In order to overcome the necessity to follow the decision in the case of *Beresford-Hope* v. *Lady Sandhurst* it was contended that the office of a solicitor is rather in the nature of a private profession than a public office. In the course of the argument reference was made to the analogous application of Miss Margaret H. S. Hall in 1901 to the Court of Session for admission to the Incorporated Society of Law Agents. The decision was the same in both cases, and Mr. Justice Joyce in the English application considered that only the Legislature could make any alteration.

Similar action has been taken in the Dominions. In Canada the Ontario Legislature passed the necessary enactment within a comparatively short time of the first woman's application. First an Act was passed enabling the Law Society to admit women as solicitors, and then in 1895 an amendment of the previous Act, admitting them to the Bar. A complete list of women admitted in the province was compiled by Mr. Justice Riddell of the Ontario Supreme Court in an article dealing with women as practitioners of law in the *Journal of the Society of Comparative Legislation* (vol. xviii, pp. 200-209). At present Quebec is the principal province which has refused to admit women to the practice of the law, although for some time the legal profession has been open to women in France. The total number in practice throughout the whole of Canada is still very small. The learned Judge sums up his conclusion: "I do not think that the most fervent advocate of women's rights could claim that the admission of women to the practice of law has had any appreciable effect on the Bar, the practice of the law, the Bench, or the people. It is claimed that it was a measure of justice and fair play, that it removed a grievance and has had no countervailing disadvantage. That claim may fairly be allowed; in other respects, the admission of women is regarded with complete indifference by all but those immediately concerned."

In connection with the admission of women to the legal profession in England it has to be remembered that the Act of last year has only opened the doors. There is no woman yet 'at the Bar,' and there is not likely to be for some time. The Act did not exempt them from any of the qualifying conditions required of men. Some have sought and obtained admission to an Inn of Court, and it is perhaps their entrance to these venerable foundations that has formed the centre of interest. The Inns of Court are popularly regarded as such close preserves that admission to them is placed in almost the same category as the admission of a woman to Masonry. It may be recalled, however, that more than one hundred years ago a woman was for eighteen years organist of the Temple Church. As the organ was then, as it is now, the finest in London, the Masters of the Bench of the two Temples are entitled to claim that they were far in advance of their time in their recognition of a woman's gifts. In the interests of historical accuracy it is necessary to add that she was called upon to resign for neglecting her duty. The Inns of Court are seminaries of learning and education from which, as James I said in his Charter to the two Temples, "many men in our own times, as well as in the times of our progenitors, have by reason of their very great merits been advanced to discharge the public and arduous functions as well of the State as of Justice," and if women are to contribute in public spheres to the government of the commonwealth it would be natural to find their names at least upon the books of the more catholic of the Inns of Court in the same way that royal and noble personages, soldiers, sailors, statesmen, ecclesiastics, dramatists, poets, politicians, novelists and journalists, and many others, are included among the eminent members of the Middle Temple. Whether in due course the women will undertake the practice of the law is quite another matter. In the search for precedents of women occupying themselves in public spheres there appears to be only one of a woman acting as an advocate, when Lady Crawford appeared in 1563 before the Court of Session in Scotland on behalf of a prisoner indicted for manslaughter (*Scots Law Times*, February 9, 1901, p. 126). It is not the present purpose to discuss the auguments for and against that course, but merely to draw the distinction between admission to an Inn of Court and the possession of the necessary qualifications to practise as a barrister, and still more to attain success in that profession.

As the result of the passing of the Act a number of other professions have opened their doors to women. Whether the change in the legal status of women thus effected at the beginning of 1920 will form a landmark in the advancement of the common weal is a matter upon which this generation cannot form a judgment. But at least the Act is the legislative record of a national tribute to the noble work done by women in a great period of stress and strain and a desire not to debar any one of the sex from a sphere in which conceivably she may find some further opportunity for service.

How Wireless Signals are Received

By Lt.-Col. C. G. Crawley, M.I.E.E.

THE ether oscillations which form the waves used in wireless telegraphy are produced by currents of electricity oscillating backwards and forwards at very high speeds, of the order of hundreds of thousands of times a second. These currents, called oscillatory or high-frequency alternating currents, are caused to flow in an elevated wire or system of wires called the aerial, or antenna, from which the wireless waves are radiated into space in all directions. Energy is thus transmitted from the sending station at the same speed as the energy which produces the sensation of light, that is at about 186,000 miles a second, but in this case the ether oscillations are much slower than in the case of light waves.

These wireless waves, which are produced by oscillatory currents, have the property of producing exactly similar currents in any electrical conductor which they meet, and it is this property which is used in the reception of wireless signals.

In wireless telegraphy, by means of a signalling key at the transmitting station, series of ether waves are sent out for shorter or longer periods of time, that is as dots or dashes, and produce oscillatory currents which continue to flow for the same periods in any conductor which they meet. At the receiving station, as at the sending station, the conductor takes the form of a system of aerial wires; and to read signals in the Morse Code, the currents produced in the receiving aerial are made to actuate electrical apparatus in such a way as to produce the dots and dashes as marks on paper, or as sounds in a telephone receiver.

In wireless telephony, the procedure is very much the same, except that the oscillatory currents in the transmitting aerial, and consequently the waves radiated, are modified in strength by the voice in a similar way to that in which the currents are modified in land line telephony. The waves, so modified, produce in the receiving aerial exactly similar currents which actuate apparatus for producing the voice sounds in a telephone receiver.

The strength of the currents in the receiving aerial will, of course, depend on the distance away of the sending station, since the ether oscillations become weaker and weaker as the distance over which the waves travel increases. A powerful sending station is one in which large currents are produced in the aerial, these currents producing strong ether oscillations which allow of the resulting waves being detected by receiving stations at great distances. Signals from the most powerful European stations can sometimes be read even in New Zealand, but efficient communication over these very long distances is not yet a practical proposition.

The Marconi Company's station at Carnarvon is the most powerful one in this country, and communicates as a rule with stations on the other side of the Atlantic, such distances, 2,000 to 3,000 miles, being the greatest over which regular communication is at present conducted. However, a French Government station at Bordeaux, which was designed and partly constructed by the American Army during the war, is very nearly completed, and will have more than twice the available power of any station now in operation.

In these large stations, separate aerials are used for sending and receiving; in fact, the receiving station is usually some miles away from the sending station, so as to allow of arrangements being made for duplex working—that is, for messages being transmitted to a distant station at the same time as messages are being received from that or another station. In some of the latest designs the most sensitive possible receiving instruments are used, and the receiving aerial is quite a small affair in the form of a loop or frame, as by such arrangements it is easier to eliminate interference from the sending station and facilitate duplex working, at the same time avoiding the great expense of a number of high masts. In the case of Carnarvon, the receiving station is at Towyn, some thirty miles away. The aerial at Carnarvon consists of twenty wires, each 3,800 feet long, supported by ten masts 400 feet high. The actual operating is carried out at Towyn, the signalling key being connected electrically by wires to the transmitting apparatus at Carvarvon.

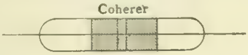

FIG. 1

In small stations, such as those in ships, the same aerial is used for transmission and reception, being switched over to the sending or receiving apparatus as required.

When signals are received from a distant station, the electric currents produced in a receiving aerial by the waves radiated from the distant station are extremely small, and apparatus must be used to enable these minute currents to release sufficient energy for working some sort of recording arrangement, whether it be one for recording sounds in a telephone receiver, or marks on a paper tape. The apparatus first used was the coherer, which consisted of a sealed glass tube in which were two metal plugs separated by a small space containing metallic filings, as shown in Fig. 1.

Oscillatory currents have the property of very greatly reducing the electrical resistance of the little heap of filings, which are then said to have cohered together, and in this state can allow a current from a cell to flow through them, and work the recording apparatus.

This coherer action was enunciated by Professor Branly in France in 1890, and a coherer itself was first used for laboratory experiments by Sir Oliver Lodge in this country in 1894. In the following year it was used by Professor Popoff in Russia as a detector for aero-electrical discharges, and in 1896 was in use by Signor Marconi as a detector in practical wireless working. This filings-coherer, along with a few other detectors whose working also depended on coherer-action, held the field for some years before being supplanted by more sensitive arrangements.

They were first succeeded by Marconi's magnetic detector, which was introduced in 1901, and quickly followed, though not supplanted, by various electrolytic devices, of which the first practical detector was introduced in 1903, in the United States, by Professor Fessenden.

The magnetic and electrolytic detectors could only be used in conjunction with a telephone receiver—that is, the message was not printed on a tape as dots and dashes, which was the case with coherer devices, but was read by ear as buzzing sounds in a telephone receiver, the duration of the sounds signifying the dots and the dashes of the Morse Code.

At first this fact of not being able to have the message printed on a tape was thought, by those not directly acquainted with practical working, to be a great drawback, as it was said that there could be no certainty that the operator wrote down the message exactly as received; whereas with the dots and dashes printed on a tape there could be no doubt of the matter. The writer well remembers many forcibly expressed opinions from that point of view when it was first suggested in the Navy that aural reception should supplant recorded signals. However, the magnetic and electrolytic receivers were much more sensitive and reliable than the filings-coherer, and it was soon found that this advantage, as well as that of the operator being able to read messages to a certain extent in spite of atmospheric and other interference, far outweighed the disadvantage of not being able to check what was received by reference to a printed tape.

The telephone receiver consists of an electro-magnet fixed close to a circular metal disc supported round the circumference. A comparatively slowly alternating or pulsating current flowing through the coils of the magnet alters the magnetic field in such a way as to vibrate the disc and produce sounds in the ear. The instrument is one of the most sensitive current detectors, but cannot respond to currents which oscillate at such very high speeds as those produced by wireless waves, so that some device must be introduced which will utilise the energy of these currents in such a way as to produce currents suitable for operating the telephone.

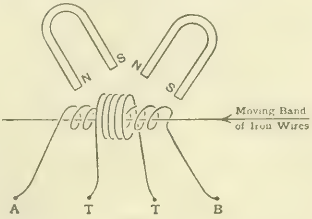

FIG. 2

In the Magnetic Detector (see Fig. 2) the minute oscillatory currents received were passed through the coil AB, and so altered the magnetic field as to produce currents in the coil TT, suitable for working the telephone receiver, which was joined up to the ends of the coil.

In the electrolytic type of detectors, as in coherers, the oscillatory currents reduced the resistance of the circuit in such a way as to allow the passage of a current suitable for working a telephone receiver. The detector consisted of two dissimilar metals, such as platinum and lead, immersed in an acid solution, the platinum having only a small point, the lead a large surface, in contact with the liquid. When at rest, a non-conducting film formed on the point, causing the circuit through the liquid from one metal to the other to have a high resistance. Oscillatory currents disturbed this film, and the resistance decreased so that the current for working the telephone could flow through the circuit.

In 1904 Professor J. A. Fleming in this country invented a detector which he called the Oscillation Valve. This consisted of an incandescent lamp with the addition of a metal plate, or cylinder, inside the bulb, connected to a wire sealed through the glass. When the lamp is glowing, the space between the filament and the plate is electrically conductive, but in one direction only—that is to say, it offers a very great resistance to a current in one direction, but very little resistance to a current in the opposite direction. If, therefore, an oscillatory current is applied, it becomes, for all practical purposes, a unidirectional pulsating current which can be used for working a telephone receiver. The device acts, in fact, as a valve for the oscillations, allowing current to flow in one direction but not in the other, and was therefore called an oscillation-valve, the resulting current being called a rectified current.

Soon after the introduction of the Fleming Valve, another form of receiver, called the Crystal Detector, was introduced. The first practical form was used by General Dunwoody in the United States, and consisted of a crystal of Carborundum in contact with a piece of metal. Various combinations of crystals and metals give a rectifying effect—that is, they convert an oscillatory current, applied across the contact, into a form suitable for operating a telephone receiver.

These Crystal Detectors are still very extensively used in ships and small stations, but the Three Electrode Valve, which was developed during the war, is now used for all long-range work.

This form of oscillation-valve may be used as a generator of electric oscillations as well as a receiver, and is such an excellent receiving and magnifying device that its introduction has undoubtedly opened up new possibilities for wireless communication.

In this valve, as its name implies, there is another electrode in addition to the filament and the plate as shown in Fig. 3. This electrode, called the grid, is usually in the form of a cylinder of metal gauze between the filament and the plate, which may take the form of an outer metal cylinder. If the telephone receiver is connected up in series with a battery across the filament and plate, there will be no sound in the telephone; but if the grid is connected to the receiving circuit so that the oscillations produced in the latter by the incoming signals cause variations of electrical pressure on the grid, then the space between the filament and plate becomes conductive, and currents from the battery flow across this space and produce sound in the telephone.

The valve may thus be looked on as a relay,[1] the minute oscillatory currents received being used to release currents from a battery which can work a telephone or other suitable receiver. This relay action may be further utilised by connecting up a number of valves in such a way that the released battery current from one valve is applied to the grid of the next one so as to release a larger current, and so on.

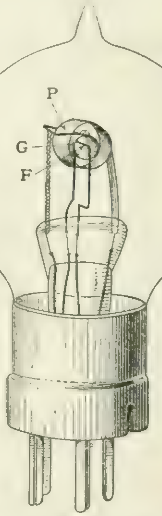

Fig. 3
P Plate. G Grid. F Filament.

When used in this manner to increase the effects of the received currents, the valves are said to be used as magnifiers; but there is a practical limit to the amount of magnification that can be produced by increasing the number of valves. It is this magnification effect that makes the Three Electrode Valve such an enormous advance over all other receiving devices, and it is also one of the properties which make it so valuable as a wireless transmitter.

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[1] A relay is an instrument which enables a small current to start the operations of a larger one.

It was by means of this apparatus used as a transmitter that wireless telephone messages were sent across the Atlantic for the first time from Arlington, near Washington, to Paris in 1915, and very early in the war it was used as a receiver by the French to intercept, by earth-conduction, messages sent on field telegraph and telephone lines, a practice which both the Germans and ourselves quickly followed. At the time, great surprise was expressed in this country at the intimate knowledge which the enemy had of our intended dispositions in the front line, and a similar surprise at our knowledge was no doubt just as prevalent in Germany. It was not long, however, before both sides had adopted means of sending messages along the wires in such a way as to make interception by the opposing side almost impossible; but there can be no doubt that the first practical use of the Three Electrode Valve, which has so increased the possibilities of communication, involved both the saving and the losing of many gallant lives.

Owing to its magnifying power, the Three Electrode Valve can be used for operating high-speed recording devices; and by using automatic high-speed transmitters, the rate of signalling can be very greatly increased. The greatest speed that can be attained by land transmission and aural reception is about thirty words a minute, and twenty words a minute is considered to be a good working speed. By automatic transmission and reception, using the Three Electrode Valve, a working speed of 100 words a minute is even now quite practicable, and much higher speeds have been experimentally obtained. In fact, it is in this direction that wireless working may show to advantage compared with long-distance submarine cable working in the near future, as such very high speeds are not practicable for the latter. Wireless working, however, whether by telegraph or telephone, is greatly handicapped, as compared with line working, by the fact that it is so liable to be interfered with, or "jammed," by other wireless signalling or by electrical atmospheric disturbances. Recently much has been done to lessen this very serious drawback, but it still remains the great bugbear of wireless communication.

NOTE.—An excellent technical account of this subject is given in *Wireless Telegraphy and Telephony*. By H. M. Dowsett. (Wireless Press, 9*s*.)

BOOKS OF REFERENCE ON HEREDITY

1st Section. L. Doncaster, *Cytology*. (Cambridge University Press, 1920, 21*s*.)

2nd Section: R. C. Punnett, *Mendelism*. (Macmillan, 1919, 7*s*. 6*d*. net.)

3rd Section: T. H. Morgan, *The Physical Basis of Heredity*. (Lippincott, 1919, 10*s*. 6*d*.)

Abraham Lincoln as now Known to Us

By Lord Charnwood

WE must consider first the national struggle in which Lincoln bore the most famous part. Soon after the United States had obtained independence, the slave trade was abolished, and the more northern States abolished slavery within their limits. Farther south the movement in favour of emancipation was checked by economic causes. By the Constitution, slavery was a question for each State to settle for itself. Conflict, however, arose about it in new States and in the territories governed by the United States as a whole. A compromise called the "Missouri Compromise" was effected in 1820 by an Act which made slavery unlawful in existing territories north of a certain line. Economic pressure, however, created in the South a desire to acquire new territory in which cultivation by slave labour could flourish; fanatical belief in the merits of slavery took possession of the South; there was some desire to re-establish the slave trade; Southern traders aspired, encouraged by prevailing lassitude on this question in the North, to get the rightfulness of slavery recognised by the law and tradition of the whole Union. In 1854 the "Missouri Compromise" was repealed. The Republican Party then arose in the North, pledged on the one hand to leave slavery unmolested where it was already lawful, and on the other to prevent its extension over any present or future territory of the United States where it had not been legalised already. In the State of Illinois great service was done to the new party by Abraham Lincoln, a lawyer in fair practice, who had been born in 1809, on the then frontier, in poor and rough surroundings. He was distinguished as a youth equally by his physical prowess and by his determined self-education, and had entered early upon a political career which for a while prospered, but had latterly lost interest in politics. Lincoln's action henceforward was marked by his reasoned and inflexible tenacity of both parts of the Republican position. In 1860 he proved to be the most available candidate of his party for the Presidency, and in November of that year was elected President, owing to a split between the Southern politicians and the party in the North which was most favourable to them. Upon his election, seven Southern "slave States" successively seceded from the Union and formed a new Confederacy; four more slave States on the border joined them when hostilities broke out; while more adhered, as did all the "Free States," to the Union. Lincoln entered office in March

1861, and within a few weeks the forces of the new Confederacy bombarded a fort at a Southern harbour which was held by the Union troops. The war which followed was just being brought to an end when Lincoln, after being again elected, was assassinated, in April 1865. It must be noted: first, that, while the whole South was devoted in maintaining its right to independence, slavery was avowedly the only cause for which the majority had chosen to exercise that right; secondly, that, while every shade of opinion as to slavery existed in the North, there was unanimity at first in declaring that the South had no right and ought not to be allowed to secede.

The reputation of Abraham Lincoln has grown in the fifty-five years since his death in a remarkable degree. This is partly the result of the disclosure from time to time of facts showing the inner history of his administration, and partly because the main features of his statesmanship can now be seen in truer perspective. When his party chose him as their candidate for the Presidency of the United States, it was less from any general recognition of his merits than from the antagonisms which had arisen to other men better known and apparently better qualified than he. One or two men of remarkable sympathy and discernment, such as Motley and Lowell, saw before long some great quality in him, but to most people in the eastern States he continued for long to seem a coarse frontiersman, while men of his own State thought of him as just one of themselves. His honesty of purpose and sincerity of utterance were very soon recognised, but people associated them with an artless simplicity, which was indeed the very opposite of his subtle, far-seeing, and reticent character.

The North sustained defeats in the war which were the more humiliating because it was far the superior in resources. It was natural to attribute this to feebleness in the administration. Moreover, the Northern people (not to speak of that minority among them in whom any defect sufficed to bring out pacifist inclinations) were deeply divided. There were those whose support of the war was confined to a determination that the Southern States should not break away from the Union, especially in certain border States whose adherence was essential to the North. There were those to whom, civil strife having once arisen, it seemed obvious that the war must be converted into a crusade against slavery, since slavery was in itself detestable, and was the whole cause of the war. Clearly understanding the point of view of both these sections, Lincoln was bound by conviction and the necessities of his position to hold aloof from both, take his own course, and keep his own counsel. Therefore both regarded him as a weak President.

Then came his assassination in the hour of victory. The pathos of this blended with the recollection of his early hardships and struggles. Besides, the man's own character had been surely gaining him sympathy. After all, he had stood the racket of the war and won through. He might have been weak, but he had been brave and patient and self-effacing. Several of his speeches were of the sort which might pass unnoticed at the moment, but would recur and recur to the mind as among the best-loved classics. And he had a certain mystery and charm, a combination of overflowing humour in his ordinary intercourse with a deep and dignified melancholy detected even by passers-by, such as grows and becomes haunting. Above all, he had been infinitely merciful and kind. So the memory of the tender-hearted conqueror became dear to Americans, as typical of the best element in their own nation, and as the memory of a very great man, about whom it was a secondary question whether he was really a great President.

But he was a very great President, whose conduct American statesmen long after, such as Colonel Roosevelt and Mr. Taft, have studied closely and treated as the supreme example of statecraft. And his statesmanship lay so much in applying to great affairs the wisdom and goodness of common life, and his skill in office was so much of a piece with the blended traits which make his strange personality fascinating, that his character has an importance to the world at large. It enhances his merits to remember that he had all the temptations which arise from an ambitious temperament, from a certain lax good-nature, and from education in the petty ways of a politician of the old school.

We may first consider his conduct of the war. The North had a terrible task before it in the conquest of the vast and difficult country of the South. There was no general staff to advise Lincoln; the North had but few trained commanders, and at first none capable of large operations; untrained, unproved men had to be encouraged and tried; local influences and popular pressure could not be ignored without disaster. The South had at first a relatively simple problem in defending itself, and was singularly favoured with military leaders. It is also plain now that Lincoln wrestled with these difficulties with wonderful patience, but the complaints of particular officers against him, and the legend of his unwise interference in military matters, still colour the views of historians. The whole question can be adequately tested by Lincoln's controversy with General McLellan, who in 1861–2 commanded the great army operating against the Confederate capital Richmond, one hundred miles south of Washington. Half the North rated Lincoln for supporting this timid general so long as he did, but the failure of his successors, and the praise of him by the great Southern antagonist, Lee, settle the point. Soldiers, naturally sympathising with an unfortunate commander, complain, on the other hand, that Lincoln did not give McLellan a fair chance. Three points in the controversy may suffice. First, Lincoln, though rightly yielding his judgment to McLellan's, long pressed him to advance due south against Johnston's forces near Washington. We now have Johnston's own account of his position, and it is decisive for Lincoln. Secondly, when McLellan was carrying out his own plan of attacking Richmond from a sea base lying south-west of it, Lincoln withheld certain forces from him. Now, it is incontestable that McLellan's demands would not, on his own showing, have left Washington sufficiently protected, that the loss of Washington would have been a deadly blow to the North at that time, and the loss of Richmond would have been but a slight blow to the South. Thirdly, when McLellan had been superseded, but reinstated in command after the disastrous failure of his successor had resulted in an invasion of the North, and when he had warded off that blow but failed to follow up his success, Lincoln abruptly and finally removed him. It is now at last known that, when Lincoln did this, he had received trustworthy information that McLellan was in treaty with pacifists in the North to let the South down easily, in consideration of their support for the Presidency. These are tiresome matters, but they show that at point after point Lincoln acted rightly where he had been obviously wrong, and we may accept it that this inexperienced man proved a strong administrator before we proceed to consider whether he was an enlightened statesman.

(*To be concluded next month.*)

Some Aspects of Carbide in the Light of Recent Discoveries

By Edward Cahen, A.R.C.Sc., F.I.C.

THE average cyclist or motorist who buys a tin of carbide never gives it a further thought. He just fills up his lamps, and there the matter rests. He does not ask what the stuff is, how it is made, or of what materials it is composed. And yet, if he only knew, the whole life-history of carbide is one of absorbing interest. Everybody to-day knows all about coal-tar and the marvels the chemist has effected with this apparently valueless and messy material: coal-tar colours are the commonplace of every exhibition; but one never hears anything about another waste-product of the gas-works, the coke that is left behind in the retorts after the gas has been distilled off with the tar and the ammonia. Now, it is from this coke, together with another very common substance, ordinary quicklime, that the carbide is made. To-day, for one nation to wage war on another with any chance of success, that nation must be possessed of sufficient supplies of at least three absolutely essential materials—nitrates, acetone, and tungsten—to say nothing of armies of men to make use of the products provided by the ingenuity of the chemists and metallurgists. Under the circumstances, it seems almost incredible that Great Britain went to war in the cause of right without assured supplies of any one of them, though it must be admitted that our Navy made it tolerably certain that we should be able to get nitrates across from Chile in quantities large enough to meet our every demand. Now, of the three substances of such paramount importance, two are directly capable of being obtained from carbide. It is for this reason that this material has assumed an importance which it has never held before.

The credit of first preparing carbide must be accorded to Woehler, a German chemist of renown, who in 1862 succeeded in making very small quantities of this material by a very lengthy and somewhat costly process, and at the same time he showed that it gave rise to a gas when it was moistened with water. Calcium carbide and the resultant gas, acetylene, however, remained mere chemical curiosities for another thirty years; and it was not till after the discovery and development of the electric furnace that carbide was manufactured on a commercial scale, and even then more or less as the result of an accident. Thomas L. Wilson was experimenting with the electric furnace, trying to get metallic calcium by heating carbon and lime together. On tapping the furnace, he found that he had a dark-coloured liquid mass, which on cooling solidified to a brittle crystalline solid. Now, if calcium had been formed on dropping this solid into water, hydrogen gas should have been given off; when this was tried, however, a gas came off which certainly was not hydrogen, for it burnt with a bright, smoky flame very unlike the flame of hydrogen, which is very nearly colourless. This new substance was calcium carbide, the same as Woehler had prepared so many years before. From such small beginnings, one discovery leading to another, this experiment led to unexpected developments.

When lime is heated with coke to the great temperatures now so easily attained with the modern electric furnace, combination takes place, with the evolution of a very poisonous gas, carbon monoxide, which fortunately soon finds some more oxygen in the air with which to combine to form the harmless gas, carbon dioxide, that we exhale. The chemist expresses these changes very simply by the two equations:

$$\underset{\substack{\text{(Calcium}\\\text{Oxide, or}\\\text{Lime)}}}{CaO} + \underset{\substack{\text{(Carbon,}\\\text{or}\\\text{Coke)}}}{3C} = \underset{\substack{\text{(Calcium}\\\text{Carbide)}}}{CaC_2} + \underset{\substack{\text{(Carbon}\\\text{Monoxide)}}}{CO}$$

$$\underset{\substack{\text{(Carbon}\\\text{Monoxide)}}}{CO} + \underset{\text{(Oxygen)}}{O} = \underset{\substack{\text{(Carbon}\\\text{Dioxide)}}}{CO_2}$$

At first the newly discovered carbide was merely used for generating acetylene for lighting purposes; and even for this many brains had to be racked and many inventions made to find out how to burn the gas without the smokiness of the flame, and how to generate it to get a constant supply without fear of explosion. The advantages of the gas for lighting railway trains, vehicles, etc., soon became apparent, and it was not long before its use was adapted for lighting isolated houses in the country. In England it has not gone much further than this stage, but in the United States and Canada it is not at all uncommon to find small townships supplied with the gas as a municipal enterprise.

The next step in the history of carbide was the discovery that acetone would dissolve about twenty-four times its own volume of acetylene at ordinary temperature and pressure, and very much more when compressed, thus affording a ready and safe means of transporting the gas in a handy manner. Iron cylinders packed with asbestos rings soaked in acetone were constructed, and the gas pumped in under pressure. With what to all intents and purposes was solid acetylene, it was not long before an entirely new use was found for the gas—namely, as a substitute for the hydrogen in the oxy-hydrogen blowpipe or torch, as it is sometimes called. Acetylene, even when it burns in the air, gives a very hot flame, but when oxygen is substituted for the air, the heat of the flame is greatly intensified. The temperature of the oxy-acetylene flame is estimated at anything between 6,000° and 7,000° Fahrenheit. The process of oxy-acetylene welding, in which these torches are used, dates from 1903, and has found a hundred different uses since then; and as a direct outcome of it, a still newer process, that of the "cutting blowpipe," may be mentioned in passing. By means of the latter, all forms of steel may be cut much in the same way as the grocer cuts through a piece of cheese with a steel wire, and with as little effort. The heat is so intense that the cut is clean, there being no time for the metal to melt before the flame passes on. To-day, only seventeen years after its invention, acetylene welding and cutting has become a common feature of every engineering shop and shipyard.

In the March issue of this magazine, in an article on the Source of Nitrogen, I told the story of how carbide had come to our aid for this all-important purpose; how, when it was heated with nitrogen, cyanamide was formed, from which all sorts of nitrogenous products could easily be obtained. Great as this discovery is, it seems but a little thing in comparison with the achievements of the chemists at Shawinigan, in Canada, during the war. The cheap electric power derived from the Falls of Shawinigan had already made this spot the centre of the Canadian chemical industry; carbide was already being made there on a large scale and of excellent quality, and many other allied industries had sprung up in the same district.

As has already been indicated, acetone is one of the essentials in warfare, for it is used in the manufacture of cordite, the standard British explosive. Cordite is not what is known as a high explosive, but is used in enormous quantities for propelling the shells, carrying the latter through the air. When one realises that it is cordite which fills the body of the huge shells used on our ships, one gets a faint idea of the demand there must have been for this material, and consequently for the acetone used in its manufacture. Although acetone does not really enter into the constitution of the finished cordite, but, like the water used in bread-making, really only assists in the mixing process, it is found in practice that little more than half can be recovered to be used again. There is little wonder, under the circumstances, that the Government soon found themselves at a loss for further supplies. Acetone is normally obtained from the distillation of calcium acetate, itself obtained from the destructive distillation of wood. This source of supply was soon found to be entirely unable to cope with the demands put upon it. Desperate efforts were made to obtain the precious liquid from any source whatever; fermentation processes were resorted to, and any starch products which could not be used for food, such as spoilt rice, for instance, were turned to account. Even village children were called in to assist, by collecting horse chestnuts, throughout the length and breadth of the country, and these were sent to the Government cordite factory at Holton Heath, near Bournemouth, in the hope that they would furnish a cheap and otherwise useless source of starch; the difficulty of getting at the starch through the various integuments of the nuts, however, proved insuperable. Late in

1915 the British Government, in their difficulty, turned to the Shawinigan Water and Power Company, to see whether calcium carbide could not again be called in to help in an emergency, as it had already done in the case of nitrogen from the air. At the time a good deal of literature existed dealing with synthetic methods of preparing acetone and similar products from acetylene, but hitherto no attempt had been made to produce the former on a commercial scale. Experimental work was started in December of that year, and after six months the construction of the plant was begun. In January 1917 acetone was being shipped to Europe. What a marvellous achievement when one thinks of it: acetone from coke and lime!—it reads like some tale from the *Arabian Nights*. The process, the main outlines only of which can be given here, falls naturally under five heads.

In the first place, acetylene had to be produced from the carbide in very much larger quantities than had ever been done before—some five or six hundred thousand cubic feet per day, in itself no mean achievement. Secondly, large quantities of mercuric oxide were required as a catalyst,[1] and this had to be made by the cheapest method possible. An entirely new electrolytic process was devised. The oxide of mercury was removed, as it was formed, in suspension in caustic soda, which was used as the electrolyte. The oxide was then allowed to settle out, which did not take long, as it is very heavy, the caustic soda being used again.

The third operation was the most difficult of all: the acetylene was passed into sulphuric acid in which the catalyst, the mercuric oxide, was suspended. Under these circumstances another gas, acetaldehyde, was formed, and this was drawn off with the unused acetylene, and separated from the latter by condensation by cooling to a low temperature.

The next step was a comparatively simple one: it consisted of oxidising the aldehyde to acetic acid. For this purpose oxygen is required, and as it was found impossible to get Linde-compressors for this purpose, air had to be utilised and a means devised whereby the oxygen could be extracted. Here again a catalyst had to be discovered. Large quantities of nitrogen were liberated as a result of this operation, which no doubt will be made use of one day to make cyanamide. The matter, however, was not of sufficient importance during the war to make it worth while recovering this waste product; all energies had to be devoted to the production of the acetone.

Having arrived at the acetic acid stage, it only remained, in the fifth and last step, to obtain acetone from this material; and here, again, this involved the discovery of a suitable catalyst, that would bring about the change. After a number of experiments, hydrated lime, with a little magnesia, was found to give the best results.

Cast-iron balls were coated with a wet paste made of these materials, and they were then placed in a long tube which could be electrically heated. After drying the catalyst on the balls, the vaporised acetic acid was passed through the heated tubes at 485° C., and it was found that the conversion into acetone was well-nigh complete. Some seventy-two of these tubes were installed, capable of producing some ten tons of acetone a day. The products from the tubes were then passed through a soda-ash scrubber, to remove the small quantity of unchanged acetic acid, which amounted to some 5 per cent. The acetone, after washing, was finally rectified in the usual way.

The cost of production of acetone from carbide was found to be much greater than ordinary commercial conditions would permit; and had it not been for the urgent need of this spirit by the British Government, the process might never have been carried through to its ultimate conclusion. It was not, therefore, a matter for deep regret when it was learnt that the need for acetic acid was greater than the need for acetone, and a request was received that they would export the former in place of the acetone, which was at first required. The need for acetic acid arose from the enormous demands made on this material for making cellulose acetate, which is used in dope for aeroplane wings.

From November 1917 onwards to the present time, the plant has accordingly been used entirely for the production of acetic acid, and, when America came in, a second plant was erected for the United States Government for the same purpose. At the signing of the Armistice this plant was just complete, and the two together would have been capable of producing some 1,600 tons of acetic acid per month. To-day the company is manufacturing synthetic acid on a commercial scale, and are able to compete very favourably on the open market. The purity of the acid, which is well over 99 per cent., is a point greatly in its favour. As to the future of other synthetic products which could conceivably be made from acetic acid, time alone will show whether they could be made a commercial success. There is no doubt but that developments could be made along the same lines as those for the production of acetone, and M. J. Marshall, of the Shawinigan Laboratories, in a paper in the special Shawinigan number of the *Canadian Chemical Journal*, gives a very good summary and review of the possibilities of the future, with a table, arranged like a genealogical tree, showing the relationship of the various products and how they can all be derived from acetylene, itself the product of coke and lime. In this table it is, to say the least, striking to find such important substances as rubber and alcohol, thus showing how far a war-time necessity may lead should the occasion arise and the pinch of necessity make itself felt.

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[1] As the whole process depends, like so many other synthetic methods, on the proper use of catalysts, it may be as well to explain exactly what is meant by this term.

By a "catalyst" the chemist means a chemical or some similar substance which helps on the reaction, but is itself left practically in the same condition at the end as at the start of the proceedings. Nearly all industrial processes depend in some way or other on the careful choice of a catalyst; the whole subject has been very carefully studied of late years.

NOTE.—The reader will find a very much fuller account of this subject in the *Canadian Chemical Journal* for August 1919. This contains many illustrations and diagrams. The articles are by many hands, and the whole subject is treated very fully.

Notes on the New German Constitution

By G. F. Bridge

A TRANSLATION of the new German Constitution has appeared in Mr. Charles Young's book *The New Germany*, and an examination of it may not be without interest. It is a remarkable combination of old German political ideas with advanced contemporary conceptions of the functions of the State. It embraces not merely government and administration—what we are accustomed to call politics—but it includes in its purview education, religion, the welfare of the child, the mother, and the labourer, and social and industrial organisation. The result of a struggle between political parties, it bears throughout the marks of compromise, and in some cases adjacent clauses appear to be, if not contradictory in a legal sense, at least inspired by a contrary spirit. But the new Constitution is not, like Bismarck's schemes, a compromise between centripetal and centrifugal forces, but the result rather of the clash of socialism and individualism. The old "States," one gathers, did not show much fight. They are reduced to ghosts and shadows. Their very name has disappeared, *Land* having been substituted for *Staat*—an expressive change, for *Staat* implies a self-governing unit, *Land* as here used merely a division of the country. The Constitution of *das deutsche Reich* is practically a unitary Constitution. In every matter on which a Government can legislate the *Reich* "has exclusive authority," or "has legislative authority" or "the right to legislate," or it "can frame general principles." The exact shade of difference which exists between some of these "authorities" and "rights" may be left for constitutional lawyers to discuss: the general outcome is that the Central Legislature is all-powerful, and may give to the Local Legislatures or withhold from them what powers and functions it thinks fit. For Local Legislatures will still exist. "Every *Land*," says Art. 17, "must have a liberal Constitution." Nay, more, there are provisions for the creation of new *Länder*, just as there are for the recognition of new States of the American Union; the consent of the inhabitants, signified by votes, being an essential condition for any such creation or for any change of frontier between *Länder*. But it seems likely that practically little power will be left to the subordinate Governments, except some measure of control in religious matters and education, some right to own commercial undertakings, and the right to "make treaties with foreign States on matters which fall within their own legislative competence" (Art. 78). The ancient glories will depart. Bavaria and Würtemberg will give up their postal departments and their stamps; all railways, waterways, and marine lights are transferred to the *Reich*, and there will be only one army for the whole country.

The most substantial remnant of the old German federative system to be found in the Constitution is the *Reichsrat*, the Second Chamber of the Legislature, which takes the place of the old *Bundesrat*. This is formed of representatives of the *Länder*, on the basis of one member for every million inhabitants, with the proviso that no *Land* shall have more than two-fifths of the total number of votes, an echo of Bismarck's politic provision for preventing a Prussian majority in the *Bundesrat*. The *Reichsrat* has apparently equal powers with the *Reichstag* in legislation, though the second sentence of the section on Legislation, "Acts of the Realm shall be passed by the *Reichstag*," seems to suggest that the latter body is to be regarded as the principal law-making authority. But, however that may be, the rights of veto and initiation are secured to the other Chamber. The solution for cases of disagreement is to be the Referendum. The President of the Realm can refer the issue to the people, and if two-thirds of the *Reichstag* are against the *Reichsrat*, he must so refer it, or else proclaim the Bill to be law, over the heads of the latter body. If the *Reichstag* insist on their position by a mere majority, apparently it rests with the President either to drop the Bill or to take a plebiscite.

The Referendum plays a considerable part in the Constitution. The President can refer any act of the *Reichstag* to a popular vote. One-third of the members of the *Reichstag*, supported by one-twentieth of the voters, can demand such a reference. One-tenth of the voters can demand the introduction of a Bill. On the other hand, there is no special stipulation for a plebiscite in the case of a proposed amendment of the Constitution; the only peculiar provision being that, if a plebiscite be held by popular initiation on a constitutional amendment, a majority of the Electorate must be in its favour (Art. 76). The ordinary procedure for effecting a change in the Constitution will be by legislation in Parliament, a two-thirds majority in a House where two-thirds are present being required in the *Reichstag*, and two-thirds of the recorded votes *in the other House*. The amendment of the Constitution will not be hampered by so many difficulties in Germany as in the United States.

In the Constitution of the Central Government there are some interesting reminiscences of the old imperial system. The President, who, by the way, will be "elected by the whole German people" (Art. 41), will appoint the Chancellor, and the Chancellor will recommend the other Ministers to him for appointment. "The Chancellor lays down general policy and is responsible therefore to the *Reichstag*" (Art. 56). Nevertheless, in Art. 57, though here only, a "Cabinet" is recognised. But Art. 54 reveals the fundamental change beneath the superficial resemblance: "Chancellor and Ministers of the Realm require the confidence of the *Reichstag* for the exercise of office. Any one of them must resign should the *Reichstag* withdraw its confidence by express resolution." It is noticeable that in this connection no function is assigned to the *Reichsrat*.

A section consisting of twenty articles is devoted to "The Individual," but here we need notice only the remarkable Article 113: "The foreign-speaking parts of the Realm shall not be obstructed, either legislatively or administratively, in the free development of their ethnological characteristics, especially in the use of their mother tongue, in educational establishments, in internal administration, and in the administration of Justice." In the next section headed "The Community," a remarkable point is the guarantee of complete freedom, for the formation of associations and unions, including those of a religious nature. All such associations can acquire corporate rights, a provision which, as Mr. Young notes, repeals the Prussian law which required special legislation for the incorporation of a religious association. This principle is further laid down in Art. 137, which contains also a remarkable clause, empowering "religious associations which are public corporate bodies to tax their members on the basis of the rate assessments and subject to *Länder* legislation." A religious denomination will apparently be able to collect revenue forcibly from its adherents; the individual will be able to avoid the assessed tax only by leaving the religious body. Such a clause reveals the influence of the Roman Catholic and Evangelical Churches; cheek by jowl with it is another which shows the strength of the Socialists: "Associations whose aim is to promote the cult of a common view of life shall be on a par with religious associations." Thus are Secularism and Religion placed on a level in the eyes of the law, and a Bolshevist or Agnostic Brotherhood will have the same rights as an ancient Church. The property of all religious bodies is guaranteed to them, though, of course, all State Churches are abolished. Endowments will therefore remain, at least for the present. The anti-religious element in Germany is evidently much less strong than it was in France in 1790, or than it is in Russia. The educational system adumbrated by the Constitution is based on the foundation-stones of democratic unity and secularism. Art. 142 declares that "art, knowledge, and their instruction are free." The next article provides that "the training of teachers shall be uniformly regulated for the whole Realm on the general lines laid down for higher education": apparently in this all-important matter neither *Länder* nor Local Authorities will have any voice. The *Einheitschule* is established by Art. 146: "The foundation school, which shall be common to all, shall lead on to the secondary and higher school system." Private preparatory schools are abolished, no doubt as being inconsistent with the principle of the *Einheitschule*; but, on the other hand, private elementary schools may be established if "a minority of parents and guardians have no public elementary school for their faith or views, or if the educational administrative authorities recognise that special educational interests are involved" (Art. 147). Nothing is said about the possibility of such schools receiving grants or accepting pupils with public scholarships. Express provision for such scholarships, including maintenance grants, is made, probably for the first time in the fundamental law of any people.

Apparently schools will be in general secular, though it is nowhere so expressly stated. But there is an important provision by which, on the demand of parents or guardians (the number or proportion is not specified), "Elementary schools for their particular religious faith or their particular views shall be set up within a municipality" (Art. 146). Here again we note that the Secularist and the Christian are treated alike; the Communists in a predominantly Catholic town have the same right to demand a school of their own as the Catholics in a predominantly Socialistic town. About country schools nothing is said. All schools are to "aim at inculcating moral character, a civic conscience, personal and professional efficiency in the spirit of the German national character and of international conciliation" (Art. 148). Except in non-religious (secular) schools—it is curious that in this Article 149 these are spoken of as if they were the exception—religious instruction in accordance with the views of the denomination or body concerned will be given. The question by whom the teachers of these schools are to be appointed is nowhere touched, and as the next clause states that "the giving of religious instruction and the instituting of Church ceremonies shall be dependent on the consent of the teacher," the denominational bodies have obviously a serious problem before them.

Lastly, it may be noted that the theological faculties in the Universities are to be maintained.

That part of the constitutional document which bears the title "The Economic System" breaks, as Mr. Young says, new ground. For its provisions there is no precedent in any former Constitution: it is a wholly German contribution to the art of organising social industry; and as it is the most original branch of the fundamental law, so it may well prove to be the most fruitful and far-reaching in its results. It sets out with the principle that "the social economic system must conform to the principles of equity, with the special object of guaranteeing an honourable livelihood to all." It guarantees freedom—freedom of trade and manufacture, freedom of contract, freedom of association—and it guarantees property, at the same time as it lays down the principle that "its use by the owner must serve the common good" (Art. 153). Private ownership in land is recognised, but "distribution and cultivation of the soil shall be supervised by the State," and "all riches of the soil and all natural resources of economic use shall be under the supervision of the State," and "increment value shall be utilised for the common good" (Art. 155). As for the public good the State will supervise agriculture, so also for the public good it may organise industry. It may "transfer to public ownership private business suitable for socialisation" (Art. 156). Is "socialisation" here equivalent to "nationalisation"? Apparently not, for the next clause gives the State power "to name itself, the *Lands*, or Local Authority, as partners in the administration of such business undertakings." Further, the *Reich* may, by legislation, compel business undertakings or associations to combine, "with a view to securing the co-operation of all the productive forces of the nation, to associating employers and employed in the administration, and to regulating production, manufacture, distribution, employment, prices, as also import and export of goods, on principles of public economy." Here we have the German proposing to do, by the conscious and deliberate action of the State, what in other countries is being done by the action of individuals and self-organised bodies. Finally, the State is to throw its protecting mantle over Labour: "the labour forces of the nation are under the special protection of the Realm" (Art. 157).

The conception of the State as the overseer of industry and the protector of labour finds expression in the institution of the "Councils," which no doubt represent the measure of success achieved by the Independent Socialists and the supporters of a "Soviet" form of government in their struggle with the conservative elements in the nation. There are to be for the workers Works' Councils, District Workers' Councils, and a Central Workers' Council, all duly recognised by the law. These are to be combined with the representatives of employers to form District Economic Councils and a Central Economic Council, and these latter are to include "representatives of all important professional groups in proportion to their economic and social importance," a phrase which one must interpret as best one can. The functions of the Local Councils are very vaguely described, and here the scheme is only an outline which it is left to time to fill in; but the place of the Central Economic Council in political life is more fully defined. First, all Bills on social and economic matters must be submitted to it for consideration before being introduced into Parliament; secondly, it is entitled itself to initiate such Bills, and to appoint one of its members to support them in the *Reichstag*, while the Government is bound to submit the Council's Bills to the Legislature. On the other hand, the *Reichstag* is not bound to accept the findings of the Council, nor does the Council possess any actual legislative power or any power of veto. Its functions are purely advisory; it has a right to be consulted and to express its views, but no more. Its actual power may therefore not be great at first, but it clearly contains within itself the potentialities of an extremely influential political organ.

The Constitution, as a whole, embodies the triumph of moderate, sensible, conservative democracy. There has been a political revolution in Germany, but there has been no social revolution. From that catastrophe the nation has been saved by the solid good sense and sobriety of the majority of the people. The German of to-day does not live in the clouds. He is no dreamy idealist. With what firmness and clear-headedness he confronts the eternal problems of politics may be seen from Art. 48: "Should any *Land* fail to fulfil the obligations imposed upon it by the Constitution or laws of the Realm, the President of the Realm may constrain it thereto by armed force." And the next clause empowers him to use force to secure public order and safety, and, if necessary, partially to suspend the Constitution.

Sir William Crookes, O.M.

The Discoverer of Thallium

Sir William Crookes's death in the spring of last year at the advanced age of eighty-seven seemed to break the last link of the chain of great chemists of the past generation. He was the son of Joseph Crookes, who came to London a poor lad and worked his way to a man of considerable means by his own ability, so that he was able to indulge his son's whim to study chemistry, a profession which, it must be confessed, is still little more than a hobby.

At the early age of sixteen he entered the Royal College of Chemistry under Hofmann and at once showed signs of his great ability in research, publishing his first paper in the *Quarterly Journal of the Chemical Society* at the age of only nineteen. This was on the Selenocyanides, and the seleniferous material he used in this research was given him by his chief and came from the sulphuric acid works at Tilkerode in the Hartz; the material is of interest apart from the paper above referred to, for it was while examining it with the spectroscope some years later that Crookes made the discovery which will always be associated with his name. The spectroscope was first used as an instrument of research by Bunsen and Kirchhoff in 1860, and it was in March of 1861 that Crookes was impelled to look at his seleniferous material with the instrument, with the result that he noticed a peculiar green line, which was found to be caused by the new element Thallium. He prepared and exhibited specimens of this new metal for the International Exhibition of 1862 and gained a medal for his exhibit. The next year he was elected a Fellow of the Royal Society. The extreme care expended on the determination of the atomic weight of the new element well illustrates the accuracy which characterised all his work. In this determination he made use of the vacuum balance and encountered some quite unexpected phenomena, which on investigation led to his second discovery of the Radiometer in the year 1875. These little instruments, which one used to see in the shop windows of the scientific instrument makers in London, give one the nearest idea of perpetual motion that one can get, as one does not at first realise that it is the light which makes the small cup-like vanes rotate on their pivot in the little glass bulbs from which the air has been withdrawn.

Crookes next turned his attention to the study of the phenomena exhibited by the electric discharge in rarefied gases, and more especially to the dark space around the negative pole, which has since been referred to as the Crookes or Cathode Dark Space.

In 1880 his discoveries in molecular physics and

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radiant matter won for him the prizes and medal of the French Académie des Sciences. In his suggestion of the existence of what he called the meta-elements he seems to have foreshadowed the modern idea of isotopes, an article on which appeared in the February issue of DISCOVERY. This was in connection with his extensive study of the rare earths, the separation of which he attempted by an elaborate method of chemical fractionation assisted with the spectroscope. This work occupied more than twenty years and led to the very full study of the element Scandium.

In 1889 the Royal Society awarded Crookes the Davy medal. He was now acknowledged to be the greatest exponent of the spectroscope in this country, and it was on this account that Sir William Ramsay sent him a specimen of his newly discovered terrestial Helium for spectroscopic examination and confirmation.

Madame Curie's discovery of Radium led Crookes to turn his attention to radiography, the result of which was the invention of the spinthariscope, a little instrument for counting the scintillations of radio-active bodies.

In addition to the researches and discoveries referred to above, Sir William carried through some very important investigations for the Government and the Royal Society, chief among which was the Investigation of Glass Workers' Cataract, for which he produced a number of recipes for glasses which have proved of considerable use to the workers in cutting off the heat- and ultra-violet-rays which injured their eyes. It is quite impossible to refer to the publications of so industrious a life, but mention must be made of the *Chemical News*, of which he remained the sole editor from its inception in 1859 till 1906. It would not be right to omit reference to this great discoverer's excursions into the realms of Psychical Research, as he was just as serious about his study of Spiritualism as he was about his other scientific researches.

The reader will find a fuller biography in the *London Chemical Society's Journal* for April 1920.

Aristotle's *Ethics*

By H. Lang Jones, M.A.

Headmaster of Willaston School, Nantwich

" *Idou, chelīdōn! chelīdōn!* "

The cry, started by a keen-eyed youngster, is quickly caught up by others; and it acts like a charm. Wrestlers relax their grip, boxers cease to spar, throwers of disc and javelin pause in act to hurl, jumpers drop their weights, runners step back from the mark—even the trainer's switch is lowered; the older men strolling up and down the covered track turn and come out into the open; the lively groups in the porticoes and the rooms and recesses behind them break off their talk, and crowd into the spaces between the columns, their eyes blinking in the glare of the noonday sun.

" A swallow! a swallow! there it is." Across the courtyard it shoots, like a dark meteor against the background of gleaming marble, dives into the shadows where hang last year's nests " under a white Greek architrave," flashes out once more into the living sunlight, and is lost in the blue of cloudless skies. " It's spring now," say the boys; and a couple of them (come to Athens with their parents, across the water from Rhodes, to see the stage-plays at the great spring festival of Dionysus) begin to chant—

> " She's come, she's come, the swallow is here,
> That brings the season of the year! "

Gradually the Lyceum resumes its wonted aspect of activity, with the naked bodies performing their varied movements in the courtyard and on the running-track, or in the cooler park beyond, while in the shadows of the colonnades breaks out afresh the clatter of tongues and nimble play of wits. Let us approach that group which is slowly pacing to and fro in one of the covered walks. The speaker is evidently one to command respect, though his appearance does not show that studied negligence which is usually affected by philosophers—perhaps because he has spent some years (as tutor to a prince named Alexander) at the royal court of Macedon.

" Human good, then," he is saying as we join the group, " human good consists in activity of the soul in accordance with virtue; or, if there be more virtues than one, according to the highest and most complete. Moreover, it must be in a life that is complete. For one swallow does not make a spring, nor one fine day; so also perfect happiness is not achieved in a single day or in a brief space of time." He pauses, to refresh his memory from the papyrus roll in his hand; and his disciples busy themselves with their wax-covered tablets and the iron pencil, or " stile," which they use to write on the wax.

. . . . .

Such is the setting of the *Ethics*—Aristotle's lectures on the Character of the Perfect Citizen. A more appropriate setting could not be desired. Here, in this " gymnasium " (just such another as the Academy, where Plato taught, and where his school continues), is one side of our Greek education—the training of the Body—in full operation before our eyes; let us, who make it our resort, use what is before us as we discuss the other side—the training of the Soul. The trainers yonder have their principles and rules; but these are useless except in practice. Some, in considering what Character *is*, shall endeavour to determine also what it *ought to be*. "It is well said that a man becomes just by performing just actions, and self-controlled by acts of self-control. Yet most people neglect this, and, resorting to abstract theorising, fancy themselves philosophers, and hope by this means to achieve excellence—like invalids who pay careful attention as the doctors prescribe for them, and yet fail altogether to carry out their instructions."

And it is no more accident that leads Aristotle to draw so many of his illustrations from the training and treatment of the human body. One example has been given; here are others: "Too much exercise may impair the strength, as well as too little; and an excess and a deficiency of food and drink are both alike injurious to health." . . . "It is possible to go wrong in many ways, but right in one only; consequently the one is easy, and the other hard—easy to miss the mark, and hard to hit it." . . . "Men's actions make them what they are, as is clearly seen from those practising for an athletic contest: they are continuously in action." . . . "As in the Olympic games it is not the finest or strongest men present who are crowned victors, but only those who take part in the contests (for the prize-winners are found among these), so in life it is, of the men of noblest character, those who act rightly to whom the prizes are given." . . . "The prize of virtue is happiness."

Yet it must not be thought that the Greeks, least of all that men of the stamp of Aristotle and his pupils, were obsessed by athleticism. That their interests were by no means confined to bodily health and training can be seen by a glance at the other sources of those illustrations which at every turn illuminate and enliven the *Ethics*. Religion, mythology, history, politics, law, warfare, navigation, commerce, manufacture, ethnology, natural history, physiology, physics, mathematics, logic, art, literature, drama, music—all these are laid under contribution; and there is constant reference also to the tenets of other schools of thought, and to the traditional philosophy of proverbs.

Throughout this wealth and variety of illustration runs an unmistakably *personal* note—which is one of the reasons, indeed, for concluding that in the *Ethics* we have the substance of lectures rather than a formal treatise. We seem, for instance, to see the twinkle in those "small eyes" of his, as Aristotle refers (apropos of the pleasures of Touch) to the gourmand who "wished that his throat could be longer than a crane's"; or reminds his hearers that "people eat sweets in the theatre chiefly when the performance is indifferent"; or tells the story of the man who justified his beating of his father on the ground that

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"it runs in the family." And we can even catch the note of tenderness in the speaker's voice when he instances that "there is something splendid about a beautiful mug or ball as a gift for a child, though the actual cost may be paltry"; or when he drops such a remark as this: "Children think those things best which are precious in their eyes."

The illustrations of the *Ethics*, then, reflect its setting in a peculiarly vivid way, both in particular—the actual scene of the discourses—and as regards the whole life and interests of the teacher and his disciples. The same light, in fact, is thrown on the *Ethics* by its illustrations as is thrown on the Gospels by the Parables, which not only reflect the general life of the day, but also bear, in almost every instance, the stamp of their origin, whether in Galilee or in Jerusalem. And a further parallel may be drawn between the *Ethics* and the Gospels. While making full allowance for the difference of sanction, we may venture to claim that the teaching of the Gentile philosopher also is of permanent value—that he still has a message for us to-day. Grounds for this claim will have appeared in some of the extracts already given; let me conclude with a few passages—some of which, indeed, approximate very closely, in content if not in form, to familiar sayings of the New Testament—in which more abundant justification may be found:

"Friendship requires what is possible, and not what is strictly due; for this is not possible in every case—for instance, in the honours paid to gods and parents: to these no man can ever make a full return." . . . "It is true of the good man, also, that he acts in many ways for the benefit of his friends and his country, and will even, if need be, lay down his life for them; for he will throw away money and honours and all the good things for which men contend, claiming for himself that which is noble and right; and he will prefer a great and short-lived joy to one that is tame and lasting, and a single great and noble action to many that are of small account." . . . "No honour is given to the man who makes no contribution to the common stock." . . . "An evil man can do ten thousand times as much harm as an evil brute." . . . "A man whose sickness is produced by reckless living and disregard of the doctors might have avoided that sickness at the outset, but now he has lost control he cannot help it any longer—just as he who has let a stone fly from his hand cannot recall it, and yet the throwing of it depended upon him." . . . "The training in definite habits from earliest years makes not a little difference, but a great deal—in fact, *all* the difference." . . . "Rest is not an end in itself, but only a means to renewed activity." . . . "Enjoyment is found in the activity of the present, the hope of the future, and the memory of the past." . . . "He who, loving the truth, speaks it in indifferent matters, will speak it still more in matters that are not indifferent." . . . "We must not listen to those who would have us as man care only for man's affairs, or as mortal only for such things as are mortal; rather should we, as far as we are able, make ourselves like immortals, and use every endeavour to act according to the highest that is in us." . . .

Let so much have been said (as he would put it) concerning Aristotle and his *Ethics*.

There is a translation of the *Ethics*, by Chase, in the "Everyman's" Library (2*s.*); this has a useful bibliography, and an introduction by J. A. Smith—to the last paragraph of which special attention may be drawn. There are other modern translations by Peters (6*s.* 6*d.*) and Welldon (8*s.* 6*d.*). The "Loeb" edition (parallel text and translation) is, unfortunately, not yet out, though it is in preparation. The best plain text is Bywater's (Oxford), with its instructive index. Burnet's edition (15*s.*) has commentary. Mention may also be made of Muirhead's *Chapters from Aristotle's Ethics* (9*s.*), and Stock's *Aristotle's Ethics for English Readers* (6*s.*).

Reviews of Books

Psycho-Analysis. By MISS BARBARA LOW, B.A. (George Allen & Unwin, 5*s.* net.)

The publisher kindly sent me two copies of this work (one of which, may I say? I returned), and perhaps Miss Low, by the methods of psycho-analysis, can explain why the former of these phenomena occurred. The book contains an account of the gist of Freud's work on the psychology of the unconscious as described in his books on Dreams and on the pyscho-pathology of everyday life. This account is given in a plain and understandable way, and, without sacrificing any salient points of the theory, by omitting the unnecessarily objectionable illustrations which occur in Freud's books. The chapters deal with the scope and significance of pyscho-analysis, mental life—conscious and unconscious, repressions, the rôle of the dream, treatment by psycho-analysis, and probable social and educational results.

A list of authoritative books on the subject is appended, and Dr. Ernest Jones, the President of the British Psycho-Analytical Society, contributes an introduction. A book to read in commencing a study of this subject.

Popular Chemical Dictionary. By C. T. KINGZETT, F.I.C. (Baillière, 15*s.* net.)

A dictionary of this kind should be scientific yet simple, comprehensive yet concise, and as free from errors as human nature and the printers allow. To write it, the compiler must be a member of the overworking classes with a passion for explanation and a manner that never bores. Also he should avoid subscribing to a press-cutting agency, if that be humanly possible, so as to avoid being depressed by the reviews that matter. For to be scientific yet simple is hard, and as soon as you breathe the word popular you are done. We like this book very much. It should appeal to the many who in their daily life and in sickness come across chemical terms whose meaning is unfamiliar to them. The ordinary dictionary probably does not mention these terms; the full-dress chemical dictionary is too technical and too heavy, so that there is room for a book like Mr. Kingzett's, which, while aspiring to scientific accuracy, attempts to be simple.

In several cases, for example in Electrons, the explanation given is not a good one, but these are exceptional and the whole spirit of the book is helpful. If you wish to know what absinthe or aspirin is, or what the various inks are made of, or the constitution of verdigris, or what the average composition of coal-gas is, the dictionary will tell you without any trouble.

It might be a good thing if in a future edition an appendix were added giving the composition of the more common patent medicines and proprietary articles. What is the composition of Benger's food? what the secret of "Milton"? A compilation of this kind has already been made, but its inclusion in a useful dictionary like the one under review would make it more valuable.

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The editorial work is under the general supervision of Prof. Sir A. T. Quiller-Couch. Each volume is separately edited, but as regards notes it has been deemed wise to steer a middle course between the plain text and the heavily annotated editions of the past. Thus we start off with a very short introduction. Short notes are given at the foot of the pages containing the text (an excellent innovation), but only such as are necessary to explain obscure passages. Further comment is relegated to the

[*Continued on p. 222*

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end of the book, where an account of the author's life is given and his method discussed. Finally, questions are asked and exercises set on what has been read.

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So far, of the hundred volumes contemplated, the nine given above have appeared, and it only remains to say that they are delightful. The moderns are going to be represented by such men as Conrad, Hardy, Tolstoy, Stevenson, Anatole France, W. H. Hudson, and Edward Thomas. The standard authors will be there too.

The series promises to be a popular one, and it is a pleasure nowadays to see books being sold at less than two shillings each.

The End of the World. By JOSEPH MCCABE. (Routledge, 6*s.* net.)

This is really a popular book on Astronomy, dealing more particularly with the question, "When will this earth of ours cease to be the home of man?" So it is a pity that what sounds like a quack title has been given to it. But the book itself is a good one, and a very interesting one too, and is sufficiently cautiously written to give a reader a scientific account of all that has been happening or being speculated upon recently in astronomy, without being, in Mr. Kipling's phrase, too "filthily technical."

There are three conceivable ways, it appears, in which the earth may come to an end. It may die prematurely, it may be cut off by a violent accident, it may "pass through the slow and chilling phases of old age into the rigor of death."

To discuss these possibilities, we must take the whole universe as our parish, and talk calmly in terms of billions of miles and in millions of years. We must not be disappointed when we are told that the very *nearest* fixed star is more than a quarter of a million times farther away than the sun. We must try and visualise a comet with a tail 100,000,000 miles in length, or a nebula which is 150,000,000,000,000 miles across. Once this sort of thing is mastered, one of the most interesting of sciences becomes pleasant.

Some of the subjects discussed by Mr. McCabe are the destruction of life upon the earth by earthquakes and volcanic eruptions, or by causes leading to the withdrawal of the air we breathe or the land we live upon, or by collision in space with comets, or by the dying of the sun. And in addition he has distilled from the mass of recent literature, and condensed for our benefit, a great amount of information on astronomy. The bearing of the newer views and theories upon the established truths of the science is very clearly discussed.

The conclusion of the whole matter is that, unless the universe develops properties of which at present we are in ignorance, this little planet of ours is quite safe for many millions of years.

A Textbook of Inorganic Chemistry. In ten volumes. Edited by DR. J. NEWTON FRIEND. Volumes i, iv, v, viii and first part of ix. Price 12*s.*, 16*s.*, 15*s.*, 12*s.* 6*d.*, and 18*s.* respectively. (Griffin.)

This is a series of books on chemistry on which the editor, his authors, and the publishers should be congratulated. It is a series that has been badly wanted, and which no library which pretends to be scientific can afford to do without. Chemists, as you know, arrange the elements in groups numbering 0 to 8, so that a volume on each of these nine groups, with an extra one to take in the overflow of one, gives us the ten under notice. The information is up-to-date, and references to the literature are given at the bottom of each page. The printing and setting are excellent.

OTHER BOOKS RECEIVED

Co-education and its part in a Complete Education. By I. H. BADLEY. (Heffer, 2*s.*)

Chaos and Order in Industry. By G. H. D. COLE. (Methuen, 7*s.* 6*d.* net.)

The Historical Method in Ethics, and other Essays. By JOHN HANDYSIDE. (University Press of Liverpool, 5*s.* net.)

What is Philosophy? By G. C. FIELD. (University Press of Liverpool, 2*s.* net.)

Australian Meteorology. By GRIFFITH TAYLOR, D.Sc. (Clarendon Press, 12*s.* 6*d.* net.)

A Guide to the Observatories at Delhi, Jaipur, Ujjain, and Benares. By G. R. Kaye. (Superintendent Government Printing, Calcutta, 3*s.* 6*d.*)

The Quest of the Indies. By RICHARD DARK. (Blackwell, 6*s.* net.)

The New Psychology and its Relation to Life. By A. G. TANSLEY. (Allen & Unwin, 10*s.* 6*d.* net.)

Everyday Chemistry. By W. ROBINSON. (Methuen, 3*s.* 6*d.* net.)

Vertebrate Zoology. By PROF. H. H. NEWMAN. (The Macmillan Company, 16*s.* net.)

Applied Eugenics. By P. POPENOE and R. H. JOHNSON. (The Macmillan Company, 14*s.* net.)

Early in the autumn Mr. Cecil Palmer will publish "*The Murder of Edwin Drood: Recounted by John Jasper. Being an attempted solution of the mystery based on Dickens's MS. and Memoranda,*" by Percy T. Carden, with an introduction by B. W. Matz. The last chapters of Dickens's novel were to be have been written by Jasper in his condemned cell, "as if told of another," and Mr. Carden has acted on this hint of Forster's, working into the narrative elucidating passages which he has discovered in Dickens's manuscript. A large-scale plan is included of the Cathedral Precincts of Rochester (Cloisterham), together with several seaplane photographs of the city; and there are appendices and notes in which Mr. Carden expounds his conclusions.

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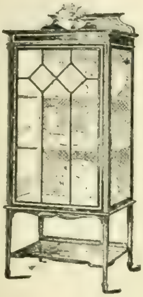

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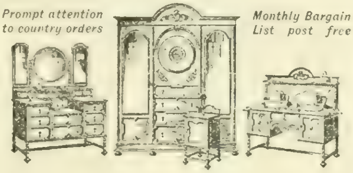

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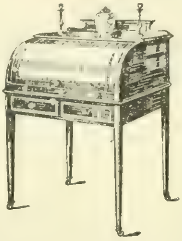

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Editorial Notes

Last year there was something of a boom in spiritualism. The subject was always before us. In newspapers and magazines, in debating societies and in private conversation, it was discussed and argued about at great length. There is no doubt that the subject has taken grip of the popular mind to a greater extent than in past years. The war is the cause of this awakened interest, and for a reason too obvious to require description. Many who do not wish to believe in spiritualism are disturbed by the adherence to the cause of several men of high character and unquestioned ability, distinguished in their walks in life. Furthermore, there are reports of occurrences which, if they be reported truly, should leave no doubt in the mind of an impartial judge that there is a queer game going on in the universe, of which at present we have hardly more than a glimmering.

* * * * *

It is well to bear in mind, before going further, that most phenomena associated with spiritualism at the present time have nothing whatever to do with what, in our best moments, we imagine spiritualism to be. Most of the phenomena are undoubtedly due to tricks played by people called mediums on their circle under the very best conditions for deception, namely concealment or darkness. Surely, if anything real happened at a séance, there would be no need of curtains and screens, or occasion for screwing down the gas. Deception it is, and it has been going on for fifty or sixty years. If anyone is sufficiently interested in the subject to wish to know how these deceptions and frauds may be brought about, let him read a report of thirty years ago, the Report of the Seybert Commission on Spiritualism,[1] which has been reissued this year.

* * * * *

The Seybert Commission met in Philadelphia—the City of Brotherly Love—from 1884 to 1887. Its object was to find out what it could on the subject of the truth of spiritualism, and to come to some definite conclusion, if possible, on the matter. The funds which defrayed the commission's expenses came from a believer in spiritualism, who, illogically enough, chose to die before his commission set to work. The members of the commission were carefully chosen, so that an unbiassed judgment might be arrived at, and throughout they behaved generously and very courteously to the mediums whom they examined. They said to these people in effect: "You say that wonderful things happen at séances: that spirits write messages on slates, that you, through them, read messages inside of envelopes, that they send messages to earth by lights, by raps, and other means, that they show themselves in material form or on photographs, and so on. All right, go ahead, get busy, let all these things happen, but let us sit beside you next time, so that we too may see these strange things; or, better still, come down to our house, be our guests, and let us all share the fun and the excitement."

* * * * *

And what was the result? The result was in every case that the manifestations at the séances were found to be fraudulent, and due merely to a little elementary conjuring, and to tricks so crudely performed that conjuring is too good a name to describe them. Ghosts were produced by dressing up somebody as a conventional ghost. Mediums disclosed the contents of sealed letters by removing the seal, opening the letter, reading and replacing it, closing the letter and putting back the seal—doing it very quickly and cleverly, of course. Rapping on a table was found to be due to the medium, or rather to the medium's toes, which, when everybody in the circle took hands, were free to strike the underside of the table. The great stunt in the eighties was writing on slates. Two slates were fastened together by a hinge on one side and a screw on the other. Between them was placed a small piece of slate-pencil—for the spirit. At a séance the medium started his invocation and the spirit wrote. It was apparently a daily, almost an hourly occurrence. The commission found, however, that, in every case it examined, the results were brought about by legerdemain on the medium's part, almost puerile in its simplicity.

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[1] Published by Lippincott. 6*s*.

* * * * *

This kind of thing is still being practised and believed in at the present time, but new tricks have, of course, been added to the medium's repertoire. In particular the wireless telephone has been a brilliant addition to his stock-in-trade. It is such a very useful thing. You require a complete telephone and an accomplice (a lady is best), and with a little practice and without a system, you may equal the Zancigs as mind-readers, and do many of the spiritualistic tricks such as the disclosure of the contents of a box by one who has never been near it. The lady accomplice puts the receivers of the telephone over her ears, and covers these either by wearing her hair like Cleo de Merode, or by wearing a suitable head-dress. The audience does not know she has the receivers on, and as there are no telephone wires noticeable, there is no reason why it should. You, the base deceiver, get possession of the information which your accomplice does not and cannot know, but which, the audience has been promised, will be forthcoming from her. It comes forth from her in due course, and without a mistake. How? wonders the audience. You have merely to talk to her by wireless from an adjacent room. Your audience will say it is wonderful, uncanny. Somebody, no doubt, will suggest that you have a system. But you haven't. It is merely common sense and the latest kind of telephone.

* * * * *

The fact that a conjurer, by means of legerdemain and apparatus, can imitate the phenomena that occur at a séance does not disprove their genuineness. The manifestations of the medium may be due to entirely different agencies. A clever conjurer can produce a spirit out of his side or from a box, so may a charlatan at a séance; it does not follow that spirits made manifest at séances and elsewhere are not genuine. The same clever conjurer can produce a rabbit out of his trousers pocket or from a hat, yet we know from experience that this does not prove that other ways of bringing rabbits into being are fraudulent. Our judgment on spiritualistic phenomena must depend upon our total experience—at séances and elsewhere. If everything that happens at every séance of which we have experience can be explained away on materialistic lines, the presumption is that the phenomena which occur at other séances of the same class can be similarly accounted for.

* * * * *

The two things that strike one most on reading this book are the gullibility of human beings (including ourselves) and the untrustworthiness of witnesses. People think they see things which do not occur, and fail to notice much that does. There is a great deal of belief in third- and fourth-hand information, and belief in things because certain authorities (who may turn out not to be authorities) believe in them. An amusing example of this is given by the Seybert Commissioners. In the late seventies, four German professors of science and philosophy, men of eminence in their respective lines of scholarship, were reported to be perfectly convinced of the reality of the observed facts of spiritualism, and that they were not due to imposture or legerdemain. This report exerted quite an appreciable influence upon the public mind in America. In getting down to the facts, the Seybert Commission found that, at the time these investigations were carried out, the four professors were completely at the mercy of the mediums. One of them was very blind, the second was suffering from cataract, the third was decidedly of unsound mind, and the fourth was so advanced in age that he did not even recognise the disabilities of his colleagues!

* * * * *

We may conclude this short account by quoting, from the appendix of the report, an account of a séance attended by Dr. Knerr, the only member of the commission who is now alive:

"It was my good fortune to meet with an *unprofessional* medium, a young gentleman of reputed honour and veracity, to whom I was introduced by a friend who had known him from childhood, and vouched for his honesty. This young man's mediumistic abilities had begun to develop with the planchette, and had reached the stage in which a drum and sundry musical instruments were played behind a curtain where he sat entranced, with his hands tied, tightly bound together by a handkerchief or cord. These séances were continued with regularity on certain nights in the week, and were confined strictly to the family circle and to a few privileged friends. There was, therefore, no temptation to deceive for gain. I came into the circle as an observer, not as believer, but was impressed by the phenomena witnessed at the first séance, in which the medium was under Indian control. There were strange sounds, guttural tones and whoops which really might have emanated from a wild son of the forest. A drum, an accordion, a zither, a mouth-organ, were all played upon. The drum-sticks kept time to music, rapped on the wall, appeared above the edge of the curtain several times, brightly illuminated as if dipped in electric light or some phosphorescent substance. As I have said, I was impressed, and might have ended in complete conversion, by manifestations from so trustworthy a source, and vouched for in such sincerity, had it not, in an unlucky moment, occurred to me to apply a little harmless test.

* * * * *

"The test consisted simply in putting a dab of printer's ink on one of the drum-sticks at the very last moment before the séance began. The result could not prove physically injurious to the medium, who had challenged investigation, nor to anyone in the circle. The result was startling. Being accorded the privilege of tying the medium's hands, I proceeded to do so with a stout cord, using a certain knot which I believe has never been known to slip or come undone. This accomplished, and while someone else fastened the medium securely to his chair, with his back to the instruments on the table, the ink, concealed in a pocket-handkerchief, was applied. In this position we left the medium, the lights were lowered and the music began. Soon were heard the deep breathings preceding the trance, then "the Indian" began to manifest, at first somewhat sullenly, as if not pleased with the conditions, some of the instruments sounded, and at last the drum-sticks commenced their tattoo. At the close of the séance, when the curtains were drawn and the lights turned up, the medium was found in his chair with his hands still tied, but great was the astonishment of everyone present at the marvellous condition of the medium's hands. How in the world printer's ink could have gotten smeared over them while under control of "Deerfoot the Indian" no one, not even the medium, could fathom.

"I believe there is an explanation for these or similar phenomena, but I must leave it to the ingenious and adroit expounders of spiritualist philosophy."

* * * * *

An account,[1] by Professor Patrick Geddes, of the life and work of Sir Jagadis C. Bose, a distinguished Indian scientist, has recently appeared. Patrick Geddes is, of course, the well-known sociologist, at present a professor in the University of Bombay. This biography is a competent piece of work, but something very much better than this is expected from Professor Geddes. It compares ill with two recent biographies of scientific men, that of Sir Victor Horsley by Mr. Paget, and that of Silvanus Thompson by his widow and daughter. A reason for this is possibly that the subject of the biography is still alive. Sir J. C. Bose was born in Eastern Bengal, and trained in physics at Cambridge. For many years he has been a distinguished investigator of physical and physiological problems, doing most of his work at the Presidency College, Calcutta, where for many years he was Professor of Physics. He is now the Director of the Bose Institute in the same city, and a man of sixty-two.

* * * * *

Bose has made himself famous by his work on plants. By means of an instrument invented by him, the magnetic crescograph, he has been able to demonstrate the growth and other movements of plants. Plants grow, as we all know, but a growth of a foot per year, if calculated out, amounts only to a fifty-thousandth of an inch per minute. So slow a growth as this is naturally invisible in nature. That it can be demonstrated directly comes as a surprise, even to those who are alive to the wonderful things that science is constantly claiming to do. The crescograph makes the movements of the plant visible by magnifying them from one million to ten million times. It can detect, and measure, a rate of growth of a hundred-thousandth of an inch per second. "Our mind cannot grasp magnification so stupendous. We can, however, obtain some concrete idea of it by finding what the speed of the proverbial snail becomes when magnified ten million times by the magnetic crescograph. For this enhanced speed there is no parallel even in modern gunnery. The fifteen-inch gun of the *Queen Elizabeth* throws out a shell with a muzzle velocity of 2,360 feet per second, or about eight million feet per hour; but the crescographic snail would move at a speed of 200 million feet per hour, or twenty-five times faster than the cannon shot. Let us turn to cosmic movements for a closer parallel. A point on the Equator whirls round at the rate of 1,037 miles per hour. But the crescographic snail may well look down on the sluggish earth; for, by the time the earth makes one revolution, the snail would have gone round nearly forty times."

* * * * *

We may quote further to illustrate how the crescograph may be used for demonstrating the growth of a plant before large audiences. A plant is connected up to the crescograph, and the growth of the plant is demonstrated by a spot of light from the crescograph rushing across a screen. "A stop-cock is turned on, admitting cooled water into the vessel containing the plant. The movement of the spot slows down and ultimately comes to a stop: the growth activity is now held in a state of arrest, a thermometer indicating the exact temperature-minimum. The plant-chamber becomes gradually warmed, and with the removal of lethargy, the growth-movement is renewed, gathering increased speed. Another stop-cock turns on a depressing agent, and the growth becomes paralysed; but a dose of a stimulant instantly removes the depression. The life of the plant becomes subservient to the will of the experimenter; he can exalt or depress its activity; he may thus bring it near the point of death by application of poison, and when the plant is hovering in an unstable poise between life and death, resuscitate it by the timely application of an antidote. It all looks like magic!"

---

[1] *The Life and Work of Sir Jagadis C. Bose* (Longmans, 16*s.* net).

But it is only an achievement of science.

* * * * *

Very recently, some of Bose's work has been called in question, the movements recorded by his crescograph being ascribed to other causes. He was challenged to give a demonstration of his instrument before some experts in physiology and cognate sciences. He accepted, and the result was that the experts testified to the genuineness of his demonstration of the growth of plant-tissues. Sir Jagadis Bose is really a physicist, and not a physiologist, by training, and consequently has had a good deal of opposition to encounter from those physiologists who foolishly dislike people of other sciences "butting in" to their subject. Part of the opposition, happily a small part, is due to the fact that Sir Jagadis Bose is an Indian.

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In the *Geographical Review* for January, a writer calls attention to South America as a promising field for the extension of cotton cultivation. At present, from Peru and Brazil, there is but a small output, only 140,000 acres being planted, but efforts are being made to increase production. In Brazil, the north-eastern coast alone is cultivated for commercial purposes, but there seems no reason, provided they can be satisfactorily irrigated, why the inland districts also should not be planted. Other parts of the continent which are considered suitable are Bolivia, Paraguay, and the plains of Northern Argentina, which together form an area greater than the cotton land in the United States. The writer considers that labour and transport difficulties are the chief to be overcome, and that in the future these areas of South America may compete successfully with the United States, and those other parts of the earth from which at present raw cotton comes.

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The Advisory Committee on Civil Aviation has just issued its report to the Air Ministry. They point out how urgent it is that civilian firms be helped financially, so that a healthy aerial-transport industry be developed, and recommend that direct assistance be given, up to a sum of a quarter of a million pounds, to firms whose planes fly over approved routes. The routes approved are London to Paris, London to Brussels, and London to Scandinavia. To qualify for financial help, a firm should carry out a minimum number of successful flights in both directions, say forty-five days of flying in three months, each flight being completed within an agreed number of hours. The civilian firm can then go ahead with an easier mind than at present, developing its own ways of doing things, improving its machines, its engines, and so on, and discovering the most reliable aerial routes. Its work, separate in its way from that of the R.A.F., will lead to results which will be of the greatest importance to both. And there can be no question of the immense strength to the Air Force that a well-developed civilian aerial-transport service would be in men, material, and ideas, in a time of need.

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Dr. F. W. Aston, of Cambridge, is continuing his brilliant work on the constitution of the elements, referred to in early numbers of this Journal.[1] It will be remembered he showed experimentally that in several cases an element whose atomic weight deviated from a whole number on the usual scale of reckoning is simply a mixture of two or more very similar elements, the atomic weights of which are represented by whole numbers. In other cases, he showed that elements were "perfectly pure," i.e. not a mixture.

He has now extended his results to Boron (atomic weight 10·1), which is a mixture of two bodies 10 and 11; to Silicon (atomic weight 28·3) which is a mixture of three bodies 28, 29, and 30; and to Bromine (atomic weight 79·92), which is a mixture of two, 79 and 81.

He finds fluorine, sulphur, phosphorus, and arsenic to be "perfectly pure." Dr. Aston has recently been appointed to a Fellowship at Trinity College, Cambridge.

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Surgeon-General W. C. Gorgas, of the United States Medical Service, who died in London last month, was a benefactor of mankind. A solitary individual working in Bangalore and elsewhere, Sir Ronald Ross, found out how to fight malaria. Gorgas applied Ross's results first to Havana, and later to Panama. By exterminating mosquitoes, he eliminated malaria and yellow fever, and so made possible the completion of the Panama Canal. That was something done. Also the doing of it aroused the world to the fact that some of the greatest scourges of mankind can be destroyed if only the right men are encouraged to go ahead and find a cure. Gorgas himself was not a discoverer, a pioneer. He was a man of action—what an enthusiastic American might describe as "a real live-wire guy right on the job every time." He was quick to appreciate the importance of discoveries in preventive medicine, and there was neither weariness in his brow nor languor in his heart in applying them for the good of his fellow-man.

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[1] DISCOVERY, February 1920, p. 45; April 1920, p. 100.

Psycho-Analysis

By William Brown, M.A., M.D. (Oxon), D.Sc. (Lond.)

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THE psycho-analytic movement dates roughly from 1893, when Breuer and Freud published their joint contribution on "The Psychical Mechanism of Hysteria" in the *Neurologisches Centralblatt.* In this and in their articles appearing two years later, under the heading "Studies in Hysteria," are summed up the doctrine of psycho-catharsis[1] for which Breuer was mainly responsible.

Charcot, Janet, and other members of the French School had regarded hysteria as a form of mental dissociation, but had been unable to explain it further.

Breuer and Freud discovered that hysterical symptoms sometimes disappeared when certain early emotionally-tinged memories were called up to the surface of the mind by means of hypnosis. An important factor in the cure seemed to be that these memories had to be lived over again in all their original emotional intensity.

The method was called the Cathartic Method, because it consisted essentially in purifying the mind by affording to the subject an outlet for his bottled-up emotion. In short, as Freud says, "The hysteric suffers from memories," painful memories of an emotional nature, which had not been adequately worked out at the time of their original occurrence. If these memories are again brought to the surface and worked off by what is called "abreaction," the hysterical symptoms disappear. Two types of hysteria were distinguished with reference to the cathartic process:

1. *Retention hysteria*, which we have briefly described.
2. *Defence hysteria*, where the earlier memories that are responsible for the symptoms seem to have been kept out of consciousness by some sort of active mental force, "a defence mechanism."

Freud discovered in several of his patients that strong urging was needed to bring the memories to the surface; and, arguing from this observed fact of mental resistance in the patients, he deduced the existence of a state of repression of the memories. With this conception of *repression* a change came over the theory, because it involved the assumption of definite groups of subconscious (or, better, unconscious) mental processes of a particular nature, and it is with this conception of repressed unconscious ideas that Freud breaks away from Breuer and develops his own general theory of the Unconscious.

Freud very soon came to the conclusion that the experiences undergoing repression were sexual in nature; indeed, that they were invariably so. In this view, also, Breuer was unable to follow him.

At first Freud held that the repressed memories were memories of real sexual occurrences in the early life of the patient. Later on, he discovered that many of these so-called sexual *traumata* were imaginations on the part of the patient. He therefore had to change his theory to harmonise with this, and so developed his characteristic sexual theory, according to which neurotic symptoms are due, not so much to buried memories of a sexual nature as to disturbances in the process of psycho-sexual development in the child's life, including the childish phantasies concerned with the sexual problem.

Freud found that he himself was not very successful at hypnosis (only succeeding in about 30 per cent. of his attempts), so he cast about for some other means, and he found that, if he simply urged his patients in the waking state to remember what they could, the memories gradually came back; especially if he let them speak at random, as things came into their minds, significant memories appeared from time to time.

This is the method of psycho-analysis (the overcoming of resistance by free association).

The method of psycho-analysis is, then, the method devised to overcome resistance to the re-entering into consciousness of these repressed memories. (Hypnosis, in doing so, is said to increase the resistance in other directions.) Freud regarded his method as one of *evading* rather than *overcoming* resistance. His first view, as we have seen, was that these memories were of a sexual nature, and corresponded to memories of actual sexual occurrences in the patient's early life. Later on he was obliged to revise that view, because he found the memories were often not those of actual occurrences, but of fancies, etc.

Gradually he came to hold a theory in which the sexual instinct is considered to be one of early origin and subject to possibilities of abnormal development.

There is a form of infantile sexuality consisting of sexual processes concerned with the feeling of pleasure produced by sucking, pleasure in connection with the excretions, as well as pleasure arising from the infliction of pain and the suffering of pain, pleasure in exhibition, etc.

Such tendencies as these sometimes appear unchanged, or even exaggerated, in adults, and are known to medical science as perversions. These partial processes undergo certain degrees of repression or transformation, especially between the ages of five and thirteen or fourteen, and what is left converges towards the production of the normal sexual instinct and life of the adult.

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[1] Literally "purifying the mind."

His theory of functional nervous diseases was, that it was the outcome and sign of maldevelopment of the sex-instinct. These partial processes had either been repressed too intensely, or their mutual relation had taken an abnormal course. Some had persisted when they should have been outgrown, etc.

The hysteric suffers from repression of perverted sexuality. If the repression had not occurred, the patient would have shown, not a normal, but a perverted sexual life. He is incapable of a normal sexual life, because the kind he would show would be out of harmony with his own character and his social environment. The patient realises that a seemingly insoluble mental conflict is going on inside him, but by psychoanalysis he is enabled to sublimate it—that is, to direct the impulse along other channels. This opens up a path along which solution of the conflict may take place, the impulse can find its fulfilment in another way. Energy is put at the disposal of the patient, and he directs it towards other ends.

We have, then, already moved far away from the conception of catharsis, and we find a change in the psychological dynamics involved. Whereas Breuer spoke of *emotion* as something that could be worked out, now Freud speaks of *libido*, something perhaps physical rather than mental, which can be shifted from one idea to another, and which, when dammed up, may produce either physical or mental symptoms.

If the repressed libido fails to find an outlet in physical symptoms—the paralyses, contractures, anæsthesias, etc., of so-called conversion hysteria—it appears in consciousness as an *anxiety state*. In other words, repressed emotion appears in consciousness as anxiety.

The nucleus of the Freudian Unconscious is constituted of the repressed tendencies and memories of early childhood, and later repressions enrich this Unconscious with memories of later life. Memories that are out of consciousness, but have undergone no repression, are called by Freud " preconscious." The resistance that stands in the way of the entry of the unconscious memories into consciousness is named the " censor." An important portion of the infantile unconscious is the group of tendencies and memories relating to the child's parents, its feelings of love towards the parent of the opposite sex, and feelings of hatred and jealousy towards the parent of the same sex. This whole system of emotionally-tinged memories is known as the " Œdipus complex," because it corresponds to the theme of Sophocles' tragedy *Œdipus Tyrannus*, in which Œdipus unwittingly kills his own father and marries his own mother.

Freud considers that the dreams of normal persons are similar in origin to the symptoms of persons suffering from psycho-neurosis. Under the physiological and psychological conditions of sleep, unconscious wishes come to dream-consciousness and obtain a disguised fulfilment. Analysis, by the method of free association, reveals the nature of these wishes, and gives the meaning or latent content of the dream—something very different from the manifest content, i.e. the dream as it is remembered by the dreamer.

Space does not permit us to go into the details of Freud's dream-theory, nor to do more than mention the processes of condensation, displacement, and dramatisation that disguise the true meaning of the dream from the dreamer himself. In a similar way, Freud undertakes to explain the unintentional slips of speech and writing of normal people, bungling actions, and momentary loss of memory for names, etc., ordinarily well known to the individual, as the effect of unconscious wishes breaking into the stream of ordinary conscious life.

At the present time Freud's theories are undergoing careful testing by unbiassed observers, out of which they are likely to emerge in a greatly modified form. In particular, the exclusively sexual origin of the psychoneuroses will probably have to be denied. On the other hand, the theory and practice of the earlier method of psycho-catharsis have been abundantly confirmed by work done on " shell shock " cases during the War, especially cases seen in the Field shortly after their breakdown. Many of these cases showed complete loss of memory for their terrifying experiences, and the recall of these memories, together with the emotion of fear that had originally accompanied them, often caused the immediate disappearance of their hysterical symptoms. The patients had not been able to react adequately to their terrifying experiences at the time, and repression had occurred. Other cases suffered from anxiety as a result of the repression, and benefited in like manner by cathartic treatment.

No reference has been made to the important factors of " repression " and " transference " in the Freudian system, nor to the modifications of theory introduced by Jung and Adler, but enough has perhaps been said to indicate the significance of the system for modern thought.

For further reading:

Vorlesungen zur Einführung in die Psychoanalyse. Von Prof. Dr. Sigm. Freud: Zweite Auflage. (H. Helber & Cie, Leipzig u. Wien, 1918.)

Psychoanalysis. A Brief Account of the Freudian Theory. By Barbara Low. (George Allen & Unwin, 1920, 5*s.* net.)

Recent Work on Heredity

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(Continued from the July No., p. 203)

(4) THE INHERITANCE OF SEX

FOR long, the inheritance of sex was as much of a mystery as sex itself. Even if we took maleness and femaleness for granted, how was it that, in each generation, roughly equal numbers of males and females were produced ? Though sex itself is still among the more mysterious problems of biology, sex-inheritance has been shown to have a basis that is almost startling in its simplicity. Putting the facts in terms of the idea set forth in our last article, the idea that unit-factors are arranged in a fixed order along the chromosomes, it appears that a sex-factor exists in a particular chromosome, and that, while two of these sex-chromosomes are present in one sex, only one is found in the other. This is the one exception to the rule that chromosomes are always present in similar pairs.

These exceptional chromosomes carrying the sex-factor are usually called the X-chromosomes. In most animals, including man and other mammals, the sex with the two X's is the female, while the male has only one X. In the male, however, the other member of the pair is present, but is not similar to the X in behaviour, and often not in shape or size. It is called the Y-chromosome. It appears to be a chromosome that has been rendered inactive so far as taking part in inheritance goes. This inactivity is often followed, as in the case of other rudimentary organs, like the hind-limbs of whales or our own appendix, by degeneration ; for the Y-chromosome is often smaller than the X-chromosome, sometimes tiny, and in a few cases altogether absent.

Thus in mammals the difference between the sexes, so far as chromosomes go, is that the female is XX, the male XY. What happens when the reproductive cells are formed ? We have seen that, with ordinary chromosomes, reduction occurs, the two members of a pair being separated. In the female, since two similar X's are present, one will be found in every ovum. But in the male, X must separate from Y, so that half the male cells will carry an X-chromosome, and half a Y-chromosome. When an X-bearing sperm fertilises an ovum, the resultant individual will have two X's, and will therefore be a female ; while when a Y-bearing sperm effects fertilisation, the resultant will be XY, and therefore a male.

A diagram will make this clear (see below).

If we interpret this in terms of sex-factors, various lines of evidence show that the real difference between a male and a female is that the female possesses two sex-units, two doses of sex-factor, while the male has only one, the Y-chromosome being inactive.

So far as it goes, this statement of the facts is adequate enough, and explains how there comes to be, on the average, an equality of the sexes in most animals.

But a great many questions are left unanswered. For instance, the males and females of the majority of higher animals differ from each other not only in the primary sex-characters, maleness and femaleness, but also in a great many so-called secondary sexual characters—for instance, the antlers of male deer ; the bright colour of many cock birds ; the moustache and beard of man ; the high voice and small hands and feet of woman ; and the differences in instinct between the sexes. Are the factors for all these differences simply part of the sex-factors, or are they quite separate, but somehow controlled by the sex-factors ? There no doubt that the second alternative is the true one.

To start with, wherever careful investigation has been made, an individual of one sex can be shown to contain the factors both for the secondary sex-characters which it possesses, and also those for the secondary sex-characters of the opposite sex, but in a latent condition. For instance, if a hen Golden Pheasant is crossed with an ordinary cock pheasant, its male offspring will show, besides some male characters derived from their father, others typical of the male Golden Pheasant. These must have been present, though invisible, in the mother. Again, when the ovary of a bird is removed, at the next moult the operated hen will appear with the plumage of a cock. Most startling of all, Steinach, in Germany, showed that, if the reproductive organs are removed from a young male rat, and ovaries from a young female grafted into the abdomen in their place, the male grows up into a creature resembling the female in every particular, not merely in size and form, but also in instincts.

We must therefore suppose that the sex-factor acts like a switch ; one dose of it, in mammals, turning on a set of conditions which permit of all the male characters developing, two doses turning on the conditions that allow femaleness and female characters to appear.

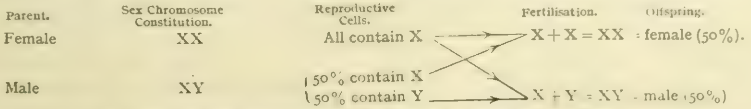

DIAGRAM OF SEX-DETERMINATION BY MEANS OF THE CHROMOSOMES.

Further, sometimes it may be possible to alter these conditions, so that some of the male characters begin to appear in a female, and vice versa.

We are all therefore double, as far as secondary sex-characters go ; but only one set is generally allowed to develop, while the other is kept latent. Sometimes, however, it is not kept completely latent ; and so come about the abnormal individuals with a mixture of the psychology of the two sexes, or even a reversal of sex-impulses. They are a problem to the psychoanalysts, and are often looked upon with great moral reprobation by ordinary people. But, in many cases, there can be no doubt that their condition is no fault of their own, but due to some slightly irregular working of part of the machinery of sex-determination. They are, in fact, what Metschnikoff called " disharmonies " in biology.

Finally, there remains the problem of controlling sex-determination experimentally. The problem is still very incompletely investigated. In frogs, there is no doubt that delay in fertilisation causes preponderance of males ; and in birds and moths, crosses between different varieties or species often result in individuals which ought, by their chromosomes, to be females, being transformed, sometimes incompletely and sometimes completely, into individuals of the other sex.

In general, we may say that it is becoming increasingly probable that, while the mechanism of the sex-chromosomes provides the usual basis for sex-determination, yet other influences may sometimes modify or override this mechanism, and that within the next few decades we shall probably be able to control, in some degree, the determination of sex in many species of animals, and possibly even in man.

(5) Heredity in Man ; and Research in Heredity

What grounds are there for believing that inheritance in man is based on the same arrangement of factors and chromosomes, and follows the same rules and laws, as in the lower animals ? The answer must be that inheritance in man is of the same description as in the rest of organised nature. The only essential differences between man and the lower animals lie in his brain and mental powers ; the rest of his physical basis is in every way similar to theirs, and we should expect it to have the same mode of inheritance. Further, although naturally we cannot conduct on man, generation after generation, the elaborate breeding experiments necessary to clear up the inheritance of a number of characters, yet some human traits have been shown to be transmitted in a Mendelian way. A type of malformation, known as brachydactyly, for instance, in which the fingers are abnormally stumpy, is inherited as a simple Mendelian dominant ; while hæmophilia, or the failure of the blood to clot properly, and some forms of colour-blindness, are inherited precisely in the way which we should expect for characters whose factors are lodged in sex-chromosomes.

But there remains the question, How far are mental qualities inherited, and if inherited, is their inheritance Mendelian ? To that it is as yet impossible to give a definite answer. The researches of Galton have shown us that many mental aptitudes are definitely inheritable, and if, as seems more and more certain, mental characters are associated with the physical characters of the cortex of the cerebral hemispheres, there is an immense weight of probability for the view that they are determined in heredity in the same way as any other characters of the organism.

Mendelian analysis, however, is another matter. Even with comparatively simple physical problems, this may bristle with difficulties. For instance, size in animals for many years evaded factorial explanation. Only recently has Punnett shown us that, in fowls at least, it appears to be due to Mendelian factors. The analysis of mental qualities is incomparably more difficult, partly because we cannot carry out definite breeding experiments, partly because of the inherent complexity of the characters involved, and partly because actual mental structure is so plastic and so largely determined by environment.

Since mental qualities are the dominant ones for humanity, it becomes clear that any legislation embodying what may be called positive eugenics is not, in the present state of our knowledge, practical politics.

By negative eugenics, however, we might even now accomplish much. There is a large body of evidence, for example, that a certain type of feeble-mindedness is inherited along Mendelian lines. If this is so, we can do a great deal towards diminishing the suffering and waste which it entails by preventing the reproduction of the feeble-minded, who, as a matter of fact, at the present time, have a very high birth-rate.

We have, however, reached a stage where eugenics can and should become a real science. Before Galton's time, it was the vision of isolated philosophers. During the last fifty years, it has won for itself a position as a political idea to be reckoned with. The recent development of genetical research has opened the way for a scientific study of human heredity. When this has been accomplished, we shall be ready for positive eugenics, content not merely to raise the average of society by cutting off the lower strata, but ambitious to heighten the maximum of human attainments, and definitely to assist the upward tendencies of evolution.

(6) Research in Genetics

We have at last, through Mendelism, a real science of animal and plant breeding—the science of genetics.

The new outlook which this has brought enables us to look at animals and plants in a new and illuminating way. A living animal is, above all, an individual, a single whole, with parts organically connected and working together. But from the standpoint of evolution, an individual animal is merely the guardian of the race, the beautiful and complex casket in which the reproductive cells are matured. As Samuel Butler put it, "a hen is the way one egg produces another egg." The view-point brought out by the study of inheritance combines both the others. The race is looked upon as in essentials a specific kind of living substance in which dwell a host of unit-factors. It is these unit-factors which determine the characters of the individuals. Not only this, but the unit-factors are capable of alterations, and these alterations may be permanent, giving rise to what we call mutations in the characters of the individual animals. From the standpoint of genetics, an animal is simply the product of the interaction of these unit-factors. In cattle, for instance, milk-production, colour, the possession of horns, size, shape, and many other characters are known to depend on such factors. When, therefore, we have proceeded far enough with breeding experiments on cattle to test the relations between the factors for these various characters, we shall be able to write out some sort of genetic formula for the different breeds of cattle. In the same way a chemist writes out formulæ for the structure and composition of his chemical compounds; and the real value of those formulæ in chemistry is that, by studying them, he is able to understand how these compounds will work—how they will react with various other compounds in one or another set of conditions. In the same way, a genetic formula—say of a breed of cattle—will not merely tell us that these animals have a particular arrangement of unit-factors: it will also tell us how those unit-factors will develop—that is to say, the characters of the individual cows of the breed; and also how they will interact with other sets of unit-factors—in other words, what we may expect in crossing the breed with another.

But work of this kind is very technical; the carrying out of it will demand, for all large animals, long periods of time, and the formulæ will be very complex. It is to be hoped that eventually the State will step in, and establish a National Genetical Laboratory on the same general basis as the National Physical Laboratory—as a place which will keep in touch on the one hand with the pure research being done in Universities and elsewhere, and on the other with the needs of agriculture and the community in general. Such an institution would, as a matter of fact, consist of a number of scattered stations, one concerned with the genetics of cows, others with those of wheat, or of pigs, or of potatoes. But the central organisation would be there, and would be the clearing-house for genetical work of importance in practical breeding, a register of all the known characters of all domestic animals and cultivated plants, and the recognised centre to which farmers could turn to ask for advice as to their breeds of stock and their strains of roots and cereals.

Experiments such as those of Professor Biffen at Cambridge on wheat, and of Pearl in America on fowls, show that the time is nearly ripe for such a scheme. What Government will earn fame for itself by daring to extend the Ministry of Public Health to include Eugenics, and that of Agriculture to include Genetical Research?

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The First Description of a Lake-village

By W. R. Halliday, B.A., B.Litt.

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In 512 B.C. Darius, the greatest of the Persian kings, was free to turn his attention to the problems of his western frontier. His successful revolution against the impostor who for a time had usurped the throne of Persia, had been followed by the restoration of order in the large empire conquered by his predecessors. In the east he had carried their work to completion and the advance to Kashmir had established a satisfactory frontier. Above all, he had constructed an effective system of provincial administration which was to survive even the incompetence of his successors on the throne of the king of kings. In the west, however, work remained to be done. His western frontier, as it stood, was unsatisfactory, for the problems of nationality were as insistent in the days of Darius as in those of the Emperor Franz Joseph. Neither the Dardanelles nor the Aegean was an adequate barrier between his western subjects and their free kinsmen beyond his borders, whose example and sympathy alike incited the spirit of insubordination. These subjects could not be denationalised; the only alternative was to extend his frontiers to include their fellow-nationals, who were as yet free, and in consequence Darius embarked upon the "European policy" which was to lead to the Persian invasion of Greece. His so-called "Scythian expedition" in 512 B.C. probably achieved its object in making the Lower Danube his north-western frontier; and the fruits of this campaign were secured by the subsequent conquest of the Thracian sea-board by Megabazus, the most trusted of his generals.

Megabazus was on the whole successful in his mission. As a result of his campaign the northern coast of the Aegean was brought under Persian sovereignty and Macedonia within the Persian sphere of influence. A minor reverse, however, provided Herodotus with the excuse for inserting a brief ethnological digression which is of the very greatest interest to students of the early history of Europe. Some of the hill tribes, he tells us, successfully resisted the Persians. "They likewise who inhabited Lake Prasias" (the modern Lake Tachynos, familiar to those who have visited the Struma Front), "were not conquered by Megabazus. He sought indeed to subdue the dwellers upon the lake, but could not effect his purpose. Their manner of living is the following. Platforms supported upon tall piles stand in the middle of the lake which are approached from the land by a single narrow bridge. At the first the piles which bear up the platforms were fixed in their places by the whole body of citizens, but since that time the custom which has prevailed about fixing them is this. They are brought from a hill called Orbelus, and every man drives in three for each wife that he marries; and this is the way in which they live. Each has his own hut, wherein he dwells, upon one of the platforms, and each also a trap-door giving access to the lake beneath; and their wont is to tie their baby children by the foot with a string, to save them from rolling into the water. They feed their horses and their other beasts upon fish, which abound in the lake to such a degree that a man has only to open his trap-door and to let down a basket by a rope into the water and then to wait a very short time, when he draws it up quite full of them." [1]

When Rawlinson published the translation from which I have quoted, the pile-dwellings of the Swiss Lakes had been recently discovered [2]; but the full interest of the description given by Herodotus was not yet apparent. For archæological investigation has since revealed that buildings of this character are spread over a wide area from Hungary to Switzerland; and the remains of similar villages are to be found in the Italian Lakes.

Indeed the construction of pile-dwellings in lakes or marshes is one of the most important features of the end of the Stone Age in Central Europe; and the fishermen of Lake Tachynos, who under favouring natural conditions retained their original mode of living into the fifth century B.C.,[3] must belong to an offshoot of the same race as the Bronze-Age invaders of Northern Italy.

The earliest pile-dwellings on the Italian Lakes belong to the beginning of the Bronze Age, and it is probable in fact that their builders first brought the use of that metal into Italy. Whether these settlements were due to a single invasion from Switzerland or to two different streams of migration, one from the Swiss lakes and the other direct from the Danube valley, is a matter of dispute; but that their builders were an intrusive people belonging to the Central European stock is certain. They differ from the previous Neolithic inhabitants of Northern Italy alike in their funeral customs, their mode of dwellings, and their degree of civilisation. Their Stone-Age predecessors in Italy buried their dead. The contracted position of the skeleton at burial, secondary burial (i.e. the burial of the bones after the flesh has been artificially removed or allowed to decompose), the breaking of objects buried with the dead man for his use in the next world, and the use of red ochre for painting the skin of the living or the bones of the dead are characteristics which the Italians of the later Stone Age share with other branches of the Neolithic race of the Mediterranean area. Evidence for the earliest Italian lake dwellings is unfortunately lacking, but in the full Bronze Age it is certain that the lake-dwellers did not bury but cremated their dead. The body was burned and the ashes buried in the earth in an urn covered with a flat stone or an inverted basin. Bronze objects, often broken before deposition, have been found buried with the ashes.

Again, the previous inhabitants of Northern Italy lived, as indeed their descendants in the Ligurian hills continued to do in the days of Diodorus Siculus,[4] in caves or rock-shelters or in villages of curious circular huts. A circular or elliptical hole was dug in the ground, sometimes more than three feet in depth, and its sides were continued above ground by wicker-work covered with clay or skins. The lake-dwellers, on the other hand, lived in settlements like that described by Herodotus, and once more archæology has shown how accurate and trustworthy an observer was the much maligned Father of History. The form of these settlements differs, it will be noticed, from the *crannogs* of Ireland and Scotland, or the lake-village at Glastonbury. In the British Islands the lake-village was constructed upon a natural or artificial island, material being heaped up to form a foundation. The Italian lake-villages, however, consist of houses built upon rectangular platforms, which are erected upon piles driven into the bed of the lake. Their position is one of great strength for defence, as Megabazus evidently found, for they are cut off from the land by a narrow causeway sometimes of considerable length.[1]

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[1] Herodotus, v. 16. Athenaeus, viii. 35, has also recorded the existence of a Thracian tribe which fed its live-stock upon fish. The name Mosynus, by which he describes the district, suggests, that he is thinking of the same or similar dwellers in pile-villages, for the word means "a wooden hut or tower."

[2] In 1854 the first of these lake-villages was discovered in the Lake of Zurich.

[3] Herodotus' history must have been published before 425 B.C., when Aristophanes parodied its opening chapters in the *Acharnians*.

[4] Diodorus, iv. 20, v. 39. Diodorus wrote his history in the reign of Augustus (31 B.C.–A.D. 14).

The Neolithic people were pastoral. They lived by hunting or fishing and from the animals which they had domesticated, the ox, sheep, goat, horse, and ass. It is probable that they used the fruit of wild plants for food, but there is no evidence that they had arrived at the stage of agriculture. Remains of cultivated plants, however, have been found in the ruins of the lake-dwellings[2]; and the presence of spindle whorls shows that man was no longer dependent solely upon skins for his clothing. The use of metal, a true bronze, not copper, first appears in Italy with this people. One would expect further that lake-dwellers would develop some means of navigation, and in fact the remains of their canoes have been found. They are of a primitive kind, hollowed from the solid tree trunk and propelled by paddles. The essential differences between the mode of life of the lake-dwellers and those of the previous inhabitants of Italy make it certain that the lake-dwellers represent an intrusive people; while the similarity of the structure and contents of their villages built upon piles to those of the lake-dwellers of Central Europe shows us unmistakably whence they came.

Some time later in the Bronze Age than the early settlements on the Italian Lakes the basin of the Upper Danube became once more the centre of a movement of peoples who spread from their native valleys over Hungary, Bosnia, and Northern Italy. To this wave of invasion belong the later settlements on Lake Garda and the *terremare*. For the new-comers were akin to the previous invaders and, like them, were builders of pile-villages. So marked, in fact, is this characteristic of their existence that when they spread from the lakes to the dry land, they continued faithful to their old method of architecture. For the *terramara*,[3] as it is called, is the lake-village built upon dry land. Its form and orientation are uniform; though it may vary in size, in shape it is always a more or less regular quadrilateral (in fact, trapezoidal), and its eastern and western sides are roughly parallel and run north and south. It is surrounded by a moat and an embankment of earth supported on its inner side by a buttress constructed of wooden beams. The moat is fed by a channel from the nearest convenient running water. The channel discharges on to the acute corner of the embankment, which divides its waters to flow round each side of the moat, while the channel itself is curved just before its junction with the moat in order to lessen the force of the current and the strain upon the rampart. The water is carried off again by a trench about midway on the east side of the moat. Within the quadrilateral formed by the rampart and moat the area is divided by two main roads at right angles to each other running north and south and east and west respectively. The obvious similarity to the arrangement of a Roman camp goes even further, for the principal street is double the width of that which runs east and west. The entrance to the settlement was by a bridge over the moat at the southern end of the principal street. With the exception of the citadel, the interior of the quadrilateral was covered with houses built upon platforms exactly after the manner of the lake-villages, except that the piles rested not upon the bed of a lake, but upon dry land. In the centre of the eastern half of the quadrilateral and approached by the road which bisects it east and west is the citadel. This had sometimes a moat and rampart of its own, and was entered by a bridge in the centre of its western face. It consisted of a rectangular artificial mound of solid earth and contains no traces of pile structures upon it, but in its centre and on the line of the road of approach there is a trench with ritual pits similar to those found in some Roman camps.

The question has naturally been asked as to the reason for this peculiar mode of building; the answer is simply conservatism. It was at one time suggested that dread of inundation had led to the persistence of the type after the builders had left their original homes. The fact, however, that a moat of running water is a poor defence against flood suggested difficulties in this view, which has been finally disposed of by the discovery of *terremare* upon hilltops where the alleged reason cannot apply. On the other hand, their conservatism was not pushed so far as was at one time suggested by others; for the facts refute the theory that the quadrilateral within the rampart was flooded to form an artificial lake.[1] There is little doubt that the object of the moat and rampart was to provide defence, not against floods, but against human enemies; and that the houses within continued to be built upon piles simply because of ancestral fashion. The conservatism of this people indeed showed itself even to excess in the matter of sanitation. Upon the lake, the refuse of the house was naturally thrown overboard, and no doubt the ground-bait, which in this way descended through the trap-door, assisted in procuring the marvellous draughts of fishes which aroused the admiration of Herodotus. Apparently, when the village was transferred from the water to the land the housewives continued their old practices. Refuse was just dumped below the houses until the accumulation reached the top of the piles. When affairs reached this stage, drastic measures became necessary. The whole affair, refuse, platform, and houses, was set on fire and a new settlement re-erected upon the ashes of the old.

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[1] In the lake-village of Polada (Lake Garda), the double row of piles which supported the causeway connecting the settlement with the land is 100 yards in length.

[2] The evidence is not sufficiently trustworthy to make it certain that they were agriculturists before their invasion of Italy, but quite early in the Bronze Age they cultivated corn and millet.

[3] *Terramara* (plural *terremare*) is the label which has been adopted to denote a settlement of this type. Before the discovery of their real nature, the soil from the mounds, which were in fact the remains of these settlements, was extensively used by the Italian peasant for manure. This fertiliser he called *terra marna* or *terra mara*.

The *terramara* people burned their dead in open fires and buried the ashes in urns. Two characteristics, however, distinguish their burial customs from those of the earlier lake-dwellers. The burial of objects for use of the dead man in the next world is with them the exception rather than the rule. The second and most remarkable peculiarity is the close packing of the urns, which in a *terramara* cemetery are placed touching one another, and in some cases even in two layers one on top of the other. For obvious reasons the burials in the same layer cannot all have taken place simultaneously, and it follows that the urns can hardly have been buried deeper than to the neck or such close contiguity would have been impossible. The cemeteries were outside and at a little distance from the settlements of the living. In one case, at Castellazzo, the cemetery itself is in the form of a *terramara*. The ossuaries are not placed upon the earth, but upon a platform supported by piles and surrounded by a moat ten metres wide, which was crossed by a wooden bridge over its western side.

Although a *terramara* has been found even as far south as Taranto, the distribution of this civilisation is in the main confined to the country north of the Apennines. There is little doubt, however, that its authors moved south in the Iron Age and that the so-called " Villanova culture " is not that of a new race, but belongs to the *terramara* people in a new stage of their development. A branch of this people which passed into Central Italy became the ancestors of the Romans; and it is no mere accident that the general plan of the *terramara*-settlement presents so many analogies to the way in which the Roman camps were laid out.[2]

The account, therefore, of the lake-village which Herodotus gives, in itself interesting and curious, has for us a yet more curious interest than it had for the original narrator and his audience. For it is nothing more or less than the first and, I believe, the only first-hand description drawn from life of one of the lake-villages of the Central European type exactly similar to those in which the ancestors of the Romans must once have lived.[3]

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[1] On p. 228 of Professor Myres's wonderful little book *The Dawn of History* will be found a sentence which I think implies this view. If so it is misleading; for there is no doubt about the facts as regards existing *terremare*. See Peet, *The Stone and Bronze Ages in Italy*, p. 338.

[2] " Old habits of life die hard, as we know; far beyond the Apennines, and in the age of iron, Roman armies fortified their nightly camps with a ditch and wooden palisade; their huts still ranged in four-square ' islands ' like the structure-lines of the old platforms; and the bridge over the Tiber which was kept by Horatius ' in the brave days of old ' was still a bridge of piles, in which no iron nail might be found, to be cut away in an hour on the near approach of an enemy." —Myres, *The Dawn of History*, pp. 228–9.

[3] The authoritative book in English is Peet, *The Stone and Bronze Ages in Italy*, which has the rare merit of an arrangement so orderly that while the archæological evidence is adequately described and examined, the reader who is not an archæological specialist is able to ascertain the conclusions and the author's reasons for reaching them without getting lost in a maze of specialist detail. Munro's *Lake Dwellings of Europe* is out of date; his latest views will be found in *Palaeolithic Man and Terramara Settlements in Europe* (1912). There is a brief but illuminating chapter on the Dawn of History in Italy in Professor Myres's *The Dawn of History* (Home University Series.)

British and Colonial Petroleum Resources

A Review of the Present Oil Situation

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Nowadays, when public attention is so easily attracted by any matter in the slightest degree sensational, or by one which promises to provide something out of the ordinary for popular diversion, it is not difficult to appreciate the cause of a certain liveliness in that particular section of the daily Press which exists solely for the purpose of supplying its readers with articles calculated to inspire the requisite feelings of satisfaction or apprehension. No matter what the subject under discussion, exaggeration and imagination are called into play in the production of the most misleading paragraphs, and the resulting distortion of fact is only equalled in magnitude by the shameless extent to which scientific or economic principles are ignored.

Quite apart from the complexity of international politics (which surely provide food enough for the most insatiate literary appetite), since the Armistice we have had a succession of Press "scares," some with a foundation of fact, but most without any. The varied aspects of the present shortage of many of the necessary commodities of everyday life can be attributed, reasonably enough, to one of the more disagreeable legacies of the War; but the startling predictions of a world-famine in such vital essentials as wheat, coal, water, and oil—to cite only a few examples—require a somewhat closer scrutiny of their *bona fides* than the prophets of these disasters would be willing to admit. Articles of this kind, so long as they are confined to the requirements of advertisement or enhanced sales, are harmless enough, for the reader who allows himself to be influenced by their purpose assuredly deserves all he gets. It is only when they are written with the calculated intent of disturbing international relations that they assume a dangerous character; and in such circumstances, no amount of comment and censure should be spared which may proclaim or deny the validity of a particular case.

In the present oil situation we have a cogent example of Press propaganda of the very worst type, whose ulterior object is not so much the creation of an alleged oil famine scare, as the possibility of disturbing our political and economic relations with other countries; in particular the United States. It will have been apparent to those who follow carefully the happenings in the oil world, that the present agitation for a definite Imperial oil policy, to conserve our resources and relieve the tension of possible famine, is but a cloak to hide an attack on American tactics, rather than an honest attempt to review a situation which may or may not have arisen. Briefly, the arguments may be summarised as follows. On the one hand, we are told that the United States, knowing that we are very largely dependent on her for the bulk of our oil-supply, is adopting somewhat the attitude of a "profiteer" in making us pay extremely high prices for a commodity which she could easily afford to sell for less. Against this, we in turn are accused of adopting a "dog-in-the-manger" policy in other fields in which we are interested, especially in Persia and Mesopotamia, our aim being, it is alleged, the elimination of American capital and interest in future developments in those countries. And so as to bring the whole matter to the point of ebullition, the "experts" responsible for these indictments have dexterously juggled with statistics in order to demonstrate a universal decrease in oil output, an ever-increasing demand, and, in consequence, an ultimate famine in what has now become a vital asset to modern civilised life.

It is with the object of inquiring into the true state of affairs that these paragraphs have been written; and, without endeavouring to solve any of the recondite problems of British and foreign politics, it is proposed to present the reader with a survey of the position of our Imperial Oil Resources as it appeals to the petroleum technologist. This entails, among other things, an inquiry into the nature and extent of those resources and the possibilities of future development. If this be achieved, it can safely be left to individual intelligence to decide how far a political and economical impasse may or may not have been reached, and what precisely are the probabilities of an oil famine in the near or distant future.

In order to appreciate the first disturbing element in the matter, it is necessary to gain some idea of the present position of the oil resources of the United States. Writing in 1916 on this subject, Arnold, in the *Annual Report of the Smithsonian Institution*, adduced important statistical evidence showing that the total consumption of oil in the United States per year amounted approximately to 265,000,000 barrels. After surveying the possibilities of further development in the principal oilfields, he estimated the probable future supply at about 5,763,100,000 barrels, from which it is evident that in about twenty-two years from that date the United States production of oil would be exhausted. This is a somewhat pessimistic view to take of the situation, and it would seem that he has allowed the barest minimum of supply for unprospected areas in Texas, Wyoming, and other fields. If the bulk of the land to be prospected, not only in the Mid-continent but in the Gulf, Rocky Mountain, and other large fields, is only half as productive as that already proven in those fields, then his estimate of future supply falls short of the probable one by several thousand million barrels. This makes no allowance whatever for possible developments in such States as Alabama and Mississippi, which are regarded favourably in some quarters as potential oil-producers. But even admitting Arnold's figures, he himself states that the estimated supply would probably "spread over a period of from fifty to seventy-five years," mainly on account of the restricted use of petroleum as a fuel, and the gradual rise in price of a commodity of which the supply fails to satisfy the demand. Further, that before the supply of natural petroleum was exhausted, the Colorado, Utah, and Californian oil shales would be fully utilised, and artificial substitutes would largely take the place of petroleum as a fuel. From which it is seen that, while there is no need for immediate alarm in connection with the United States oil resources, there is every need of some national scheme of conservation whereby the internal resources of the country may be utilised to the greatest possible efficiency.

The appreciation of these eventualities has led to a good deal of agitation for the introduction of a scheme of this nature, and the Press has, with its customary zeal, seized upon the opportunity to spread the news of famine in furtherance of its own particular propaganda. This, together with the unsettled state of international commerce, has been sufficient to create the feeling of tension in the oil world to which we have alluded.

Whatever the issue, it is obvious that to any policy which America may feel it necessary to adopt ultimately, having for its aim the preservation of her natural oil resources, no sane person can take exception. We have to realise that, like ourselves, America has received an enormous impetus to her motor and aeroplane industry as a direct consequence of the War, and the demand for oil fuel was never so great as at present. To meet this demand she has, perforce, to call on her own resources to a greater extent than before ; and consequently, if the limit of wise output be reached, her export trade is the first to suffer, with corresponding effect on those countries mostly dependent on her for their oil-supplies. This possibility constitutes the true danger of the position, and in foreseeing it, it is only reasonable that England should be prepared to meet such a contingency with a policy calculated to relieve any strain to which the British oil industry might suddenly be subjected.

It is common knowledge that we are largely dependent on United States oil for our requirements ; and in view of the fact that that country is responsible for nearly 70 per cent. of the world's supply of crude oil, and that we at present only control about 4 per cent., the possibility of the cutting down of American supplies is one to be guarded against. Fortunately, on this occasion at least, we are not content to await eventualities ; and although a definite Imperial oil policy has so far not been made manifest, a movement in one direction has resulted ; namely, the immediate development of our colonial oil resources. To these must be added our interests in Persia and our ultimate policy in Mesopotamia, concerning which our own Government has been consistently vague. In a contemplation of these possibilities, then, our petroleum experts have been and are being employed, and already some highly interesting data have been forthcoming. For our present purpose, it will help in the understanding of the position if we review the progress made in the past and the developments possible in the future, in the various productive areas within the Imperial Dominions. And for reasons quite apart from natural precedent, it is convenient to deal with the British Isles first.

In selecting our own country as an "oil-producing area," we at once take rather an anomalous step, since although, as mother-country, England must form the ultimate political and economic keystone binding our colonies into one united whole, as a crude oil-producing centre she is sadly insignificant, a statement which will doubtless meet with severe criticism from many quarters. It must be evident, however, even to the non-technical public, that the results of the recent boring operations in Derbyshire and elsewhere have not so far justified the flowery statements of confidence which characterised the scheme in the first stages of its initiation last year. "Hardstoft" is scarcely the great success which it was destined to be, a few tons of crude oil per day (according to the latest reports) being the usual rather meagre yield. Doubtless, with more powerful plant and greater pumping this yield could be raised somewhat, but even then the result could not possibly justify the outlay of capital necessary.

Little good could be served by reiterating the text of the several warnings uttered by expert geologists, both before and after the Derbyshire enterprise was commenced last year. In a very able article dealing with the geological reasons which render it unlikely that England will ever furnish a commercial supply of oil, Mr. V. C. Illing discussed this aspect of the question in the *Geological Magazine* of July 1919, to which the reader is accordingly referred. Writing just a year later, we have to admit that his admonitory predictions have not only been fully justified, but that the search for subterranean oil-pools not only in the Midlands, but in the whole of the British Isles, is a policy only dictated by those for whom scientific principles have little or no meaning.

"Hardstoft" and kindred propositions were defended by their supporters principally on the grounds that the requisite geological structures for the preservation of oil-pools were present in the areas, and the dangerous word "anticline" was flung hither and thither as an offset to the adverse criticism which the scheme met with from high scientific quarters. To the general public, and unfortunately to many so-called oil experts, the terms "oil" and "anticline" are almost synonymous, certainly inseparable. It does not follow, because subterranean anticlines can be proved in Carboniferous strata, that there, necessarily, oil will be located. It takes a man with an "eye for country," as the saying goes, to understand three-dimensional stratigraphy ; and, unfortunately, such men are the exception rather than the rule in the technical world. However, it is easy to be wise after the event, and one can only hope that this unnecessary waste of money, in conducting what is at most only an interesting experiment, will be speedily terminated ;

and, further, that it will be a lesson to those who anticipate similar schemes for other parts of the British Isles in the future.

We cannot leave the survey of English oil prospects without reference to the oil-shale industry, which is certainly rather a different proposition from that referred to above. It is a well-known fact that at certain horizons in the stratigraphical series, carbonaceous rocks occur from which, by artificial distillation, a form of petroleum may be obtained; but at present only one large field in this country has been worked for any length of time with success, and that is situate in the Midlothian Carboniferous field of Central Scotland. These shales have yielded over forty gallons of oil per ton in the past—though this is by no means a phenomenal amount for good oil shale—whilst the by-production of ammonium sulphate to the amount of 50 lb. and over per ton has been a contributing factor of no small importance to the success of these operations.

There seems to be no reason why the production of shale oil from this centre should not be a standard industry for many years to come, as the deposits are by no means exhausted. On the contrary, further extensions of the field should be possible within the confines of the main tectonic trough in which the Calciferous Sandstone series lie in this region. While, on account of certain complexities of structure, there may be an element of risk in putting down trial boreholes for the location of deeper seams, it would not be anything like so hazardous an undertaking as that to which the country gave almost tacit assent last year in Derbyshire.

Another field has come under the public eye of late, and one which promises to afford interesting results; namely, the Norfolk oil-shale field. Very little information has been forthcoming in connection with the development here, though the reader is referred to Dr. Forbes Leslie's paper, read before the Institute of Petroleum Technologists in January 1917, for general details. Geologically, this subterranean occurrence in Norfolk is of great interest, though in the present writer's opinion the structures are difficult of elucidation without adequate borehole data, and Dr. Forbes Leslie's explanations thereof do not always seem to him conclusive. Apart from that, it is certainly a possible field, and as such, a potential asset to our home oil industry.

Other occurrences of oil shale, such as those of Kimeridge in Dorset, the so-called "Kimeridge Coal," have been worked in the past with intermittent success. The Kimeridge shale yielded at times as much as 70 gallons of crude oil per ton, with a rather small amount of by-products. The extent of the shales, however, is extremely limited, and any mining of them would necessitate working thin and probably discontinuous seams over a wide area, a process which is seldom a profitable one.

For the rest, small oil-pools probably will be met with from time to time in various parts of the country during boring operations, particularly in Carboniferous formations; but the public would be well advised to receive such reports with the scepticism they deserve, and to realise once and for all that oil, in sufficient quantity to make it a commercial proposition, is certainly not one of the many blessings which Nature has seen fit to bestow upon us.

Crossing the Channel into the main continent of Eurasia, the oilfields can be divided into two main groups for present purposes: those in which we have financial interest, and those in which we have or may have both financial and administrative interests. With the former group we are not here concerned; it includes the important fields in Russia, Roumania, and Galicia, and so long as political and economic conditions allow, constitutes an open market from which we, in common with other countries, may draw large quantities of oil for home consumption. The other group includes our own colonies in Asia and the East Indies, and our interests in Persia and Mesopotamia.

In the countries of Burma and Assam occur probably the most valuable oil resources that we possess, the Upper Burma fields being already famous for their oil-production, while the Assam fields only await development on a large scale. The comparatively recent prominence of the Burma fields is largely due to the progress made in overcoming difficulties of transport, which formerly necessitated conveyance of the crude oil for over 300 miles via the Irrawaddy River to Rangoon. With the installation of pipelines, the production has naturally increased and further developments may confidently be expected, particularly in the Minbu and Yenangyat districts. The Assam fields have yet to be fully prospected, but no doubt exists as to the great possibilities of the Tertiary deposits of the Brahmaputra and Surma basins. The petroliferous beds are here often associated with coal seams, and are located along a belt of country stretching from Chittagong approximately N.N.E. for a distance of over 800 miles. At present the Digboi field, near Debrugarh, on the Brahmaputra, is the best-known region actually working; but the results of geological survey at various points along this belt have shown most favourable indications for the location of new sites, though in some places the structures are exceedingly complex, owing to the disturbed character of the strata.

Of the Malay Archipelago, British North Borneo, Brunei, Labuan Island, Sarawak, and British New Guinea (Papua), all show indications of oil to a greater or lesser extent, though little is at present known of the commercial possibilities of the fields. North Borneo and Sarawak are perhaps the most important countries, and drilling is proceeding with a view to locating further supplies. In Papua, petroleum has been found along the same line of earth movement on which are situate the oil-bearing horizons of Java and Sumatra, and Dr. Wade has shown that the oil indications are extremely good, though conditions of climate and native labour have hitherto prevented prospecting on a large scale. Reported occurrences of oil in many parts of the Malay Peninsula have engaged the attention of geologists from time to time; but in the writer's opinion, the knowledge that we have of the geology of this region points to unfavourable conditions for the location of oil in quantity, although certain horizons in the restricted Tertiary formations may give a small yield from time to time.

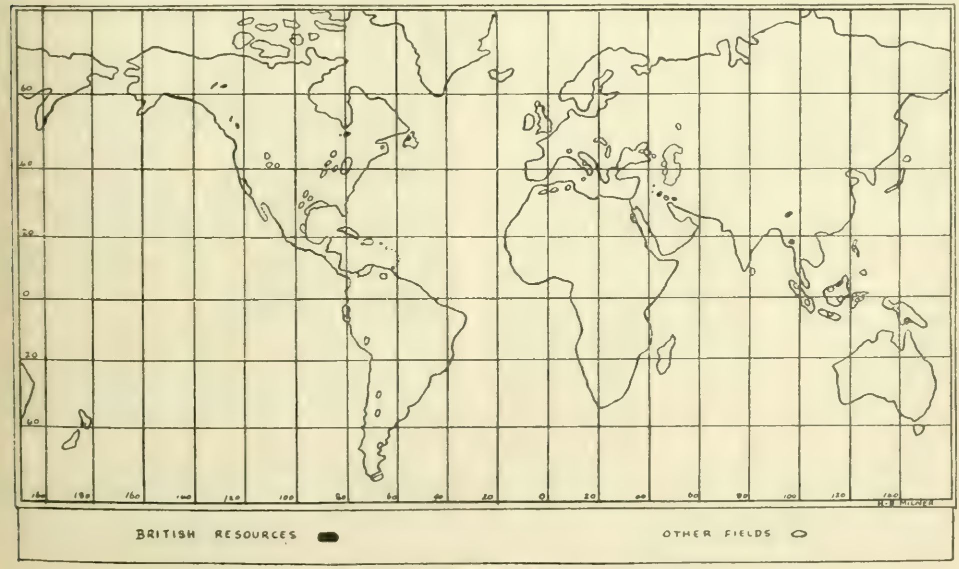
The economic and political problems with which the future of the Persian and Mesopotamian oilfields is bound up still remain to be solved, and until conditions settle down from the present deplorable state of flux resulting from the War, it is a little premature to venture upon any suggestions as to developments of the petroleum resources of this part of Western Asia. Whatever our future policy with regard to these countries may or may not achieve, once the fields are better known and more widely prospected, the resulting influence on the world's supply of oil fuel will be far-reaching. Our knowledge of the Mesopotamian possibilities is largely based on reports and opinions gained during the War, and, geologically, on analogy of structure and conditions to those obtaining in the better-known Persian field to the east. Here the petroleum deposits lie along a belt of country extending from the Persian Gulf to some miles north of Baghdad, in a direction running parallel to the Turko-Persian frontier. The best-known field is that of Maidan-i-Naphthun on the River Karun. Other districts include Daliki, Zohab, and Loristan, all of which show great promise.

Passing now to the continent of Africa, our most important field is that of Egypt, where on the coast of the Gulf of Suez, at Jebel-Zeit and at Gemsah, a few miles to the south, operations are in active progress. The oil is chiefly found in the Miocene deposits, which are still undergoing energetic examination with a view to locating further pools. Latterly, the lower limestone horizons of the Miocene series have been the subject of detailed investigation, but so far no definite results have been forthcoming. Prospecting is also in progress to the east, in the Sinai Peninsula, where geological conditions are somewhat similar to those of the main Egyptian fields, while one or two islands in the Red Sea have been surveyed, but with negative results from a commercial standpoint. Other regions in Africa have from time to time been searched for oil, notably the Ivory Coast, Gold Coast, Nigeria, and Somaliland, but in all cases the results were extremely poor and unimportant. In Central Cape Colony there have been several petroleum indications in the past, connected with the carbonaceous Karroo shales, and owing their origin to the destructive distillation of those rocks as a consequence of igneous intrusion. In Northern Cape Colony similar occurrences are found in the Dwyka series, while carbonaceous shales, with occasional show of oil, are known from the Orange River Colony and in several other regions of South Africa. A great deal of prospecting has been done in these areas, but, as far as present knowledge goes, the geological conditions are entirely unfavourable to the preservation of oil, and it is unlikely that any important supplies will ever be obtained from this part of the world. There are still large areas in Africa unknown to us geographically, geologically, and economically; and though in mineral resources she is probably one of the richest countries in the world, the prospects of locating large oilfields are, from geotectonic considerations, essentially remote. Africa, like India, is a fragment of a "lost continent," in which we find no indications whatever of those great post-Carboniferous orogenic movements which have so fundamentally affected the continental mass of Eurasia; in it we are unable to trace the results of such tangential earth stresses as were responsible for the production of structures similar to those obtaining in the important Eurasian fields.

It is otherwise with the American continent, however, where in Canada, and particularly in the West Indies, our resources are considerable. Of the Eastern Canadian fields, in New Brunswick, Quebec, and Ontario, the latter is the most important oil-producing centre. Here the fields are located on what is known as the Cincinnati anticline, a fold extending northwards from Tennessee through Western Ohio to the Province of Ontario, and on which in the States some of the richest oilfields of Ohio and Indiana are situated. The most important fields in the Province are those of Petrolia and Oil Springs in Lambton County, where oil occurs in the Onondaga Limestone series of Devonian age. It is accompanied by large quantities of natural gas, of which the most productive is the Essex-Kent field. In New Brunswick a great deal of boring has been carried out for oil and gas which has only met with indifferent results, though the oil, when met with, has been found to be of a high grade. The fluctuations in output are largely due to the selection of poor sites for boring, and to lack of penetration to sufficient depth. The exploitation of oil in this province is an example of the dangers attending promiscuous boring for petroleum without regard for anything more than doubtful surface indications. In Albert County, oil-shale deposits have been investigated which have yielded up to fifty gallons of oil per ton on distillation; these deposits have been surveyed in several areas within this region, with promising results. In Quebec, on the other hand, the results of exploration have proved unsatisfactory, both for oil and gas. One field (that of Gaspé) has yielded oil, but only in small amount, and the possibility of extensive supply is remote. The *Geological Survey* definitely advised against any further drilling within the province (1915), though this opinion has not met with general credence. In Nova Scotia, Prince Edward Island, and Newfoundland, bituminous shale deposits occur which have of late received attention; those of Nova Scotia are said to be as important as those of Scotland, and richer in hydrocarbon content. The Western Canadian fields embrace certain regions in the Yukon and North-west Territories, Alberta, Manitoba, Saskatchewan, and British Columbia, of which the Province of Alberta and the Mackenzie Territory seem to offer the best chances of future success. Prospecting in these areas has in the past been rather of a speculative nature, but with the increased data to hand furnished by the admirable work of the Canadian Geological Surveys, coupled with the experience already gained from some of the more promising ventures, future operations should meet with a considerable amount of success.

The oil potentialities of the West Indies have long been regarded as favourable, and of the five islands which have recently received attention in this respect, Trinidad and Barbados have both justified the initial work carried out. The Barbados petroleum deposits are much less important than those of Trinidad at the present juncture; they are mainly confined to the Scotland region of the island, where the oil is associated with Miocene sandstone and shale. The curious desiccated tar product "Manjak" occurs here, which has been mined considerably in the past. The Trinidad oilfields have been much more systematically developed than those of Barbados, and operations are proceeding on an ever-increasing scale. Petroleum indications are mostly confined to the southern part of the island, where the well-known fields of Tabaquite, Guayaguayare, and Barrackpore, yielding very high-grade products, are located. A great deal of prospecting yet remains to be carried out before all the resources of this island are tapped, and, with the increased facilities of transport and the installation of further pipeline systems, rapid development may confidently be expected.

There remain for our consideration the countries of New Zealand and Australia. In New Zealand there are three principal districts from which oil seepages have been known, the most important being that of Moturoa, near New Plymouth, in North Island. From this source small quantities of oil have been obtained



PRINCIPAL OILFIELDS OF THE WORLD

intermittently, while the other two fields at Waitangi Hill and Kotuku are at present insignificant, and some doubt exists as to whether these localities will ever yield a commercial supply. The oil shales of the Orepuki region are generally known, but attempts to work them profitably have so far proved abortive. Borings near Greymouth, on the west coast of South Island, have met with little success, though the area between this and Brunnei inland will probably pay further prospecting. In Australia oil has been reported from many places on many occasions, but so far no results of commercial importance have been forthcoming. Dr. Wade has investigated certain supposed oil-bearing areas in South Australia, but concluded that the prospects were not encouraging. West Australia and Victoria have shown small oil seepages in several parts, but nothing has been discovered which would warrant extensive prospecting. In New South Wales, Queensland, and Tasmania, there are oil-shale deposits which have been worked on a large scale, and it must be admitted that the petroleum prospects of the continent, as a whole, seem to be largely centred in these occurrences.

This brings our brief survey of the British and Colonial oil resources to a close. From the accompanying map the distribution of the principal oilfields of the world can be noted, of which the British resources are shaded black. It is significant, at all events from a geophysical point of view, that our most productive fields (and, at the same time, those which offer the best possibilities of successful development in the future) are confined to the zone between latitudes 0° and 30° N.; and from what has already been said, it will be apparent that to the West Indies, India, and possibly the East Indies, we have to look for future resources. While we may not hope to discover fields of anything like the magnitude of those of the United States, there are at least equal chances that our own fields, and others as yet unknown, will yield to the prospector supplies of oil which, together with that obtainable from extraneous sources, would be sufficient to carry us through for many a long year. We must not forget that there are enormous possibilities of development in other parts of the world—such as Mexico, the Gulf States, South America (particularly on the north coast), Russia, and possibly Japan. The ultimate location of a productive field in any one of these regions would be quite sufficient to postpone a critical situation, if such were likely to arise. Each new well drilled, each new area surveyed, providing the essential principles of the science be kept in view throughout, brings the chance of further supply nearer. And each addition to the world's market must tend to alleviate any suggestion of famine that may be made. At present there is no oil famine, and in the writer's opinion there is not likely to be one for several generations. Every day, almost, a new wonder is proclaimed from the realms of experimental science, and synthetical productions are ever taking the place of natural resources. The question of substitutes for petroleum as a fuel is engaging the attention of experts all the world over, and if past success is any indication of the future, we cannot justifiably regard the prospects of their work other than with complete optimism. Economy in use of existing supplies, careful prospecting on scientific lines, greater development of the world's oil-shale deposits, and the use of substitutes for petroleum wherever possible, are arguments which collectively must tell in the long-run. We have not yet exhausted Nature's resources of coal, water, or oil; we may not see a generation's supply ahead, but that does not prevent us from continuing the search.

Books of the Month

The following is our monthly selection of books which we commend to the notice of our readers.

The Rescue. By JOSEPH CONRAD. (Dent, 9*s.*)

The latest Conrad. It is a wonderful romance of the South Seas.

Esther Waters. By GEORGE MOORE. (Heinemann, 7*s.* 6*d.*)

A reissue of a famous novel of the nineties.

From the Log of the Velsa. By ARNOLD BENNETT. (Chatto & Windus, 18*s.*)

An account of a holiday spent in a yacht along the coasts of Holland and Scandinavia before the war.

Follow the Little Pictures. By ALAN GRAHAM. (Blackwood, 7*s.* 6*d.*)

A first-rate mystery story.

Reputations. By DOUGLAS GOLDRING. (Chapman & Hall, 7*s.* 6*d.*)

Essays criticising the work of well-known contemporary novelists. Clever, independent, interesting, but rather too destructive.

My Life and Other Stories. By ANTON TCHEHOV. Translated by S. S. Koteliansky and Gilbert Cannan. (Daniel, 7*s.*)

The Men of the Nineties. By BERNARD MUDDIMAN. (Danielson, 6*s.*)

Anthropology and History. By PROFESSOR WM. MCDOUGALL. (Oxford Univ. Press, 2*s.*)

A lecture delivered to a scientific society in Oxford, showing the important bearing of the study of anthropology on that of history. Dr. McDougall has recently been appointed to the chair of Psychology at Harvard.

Discovery in Greek Lands. By F. H. MARSHALL. (Cambridge University Press, 8*s.* 6*d.*)

A short account of the principal excavations and discoveries of the last fifty years in Greece, Crete, Asia Minor, and Cyprus.

Report of the Seybert Commission on Spiritualism. (Lippincott, 6*s.*)

The Life of Benjamin Disraeli, Earl of Beaconsfield. Vols. v and vi. By G. E. BUCKLE. (John Murray, 18*s.* each.)

These volumes complete the great work, and cover the period 1868–1881. The principal contents for the reader not interested specially in politics are the voluminous correspondence with Queen Victoria, and the love-letters to Lady Bradford. An interesting psychological study. "There is no tale in Eastern or Western romance," says a reviewer, "to be compared, for successful adventure, with the Life of Benjamin Disraeli."

Space and Time in Contemporary Physics. By PROFESSOR M. SCHLICK. Rendered into English by Henry L. Brose. (Clarendon Press, 6*s.* 6*d.*)

Einstein's theory, and what it involves, dealt with in plain, non-mathematical language.

Abraham Lincoln as now Known to Us

By Lord Charnwood

(*Continued from July No., p.* 211)

THE preceding article has perhaps given indications enough that Lincoln was a firm and sagacious administrator in matters in which his contemporaries seemed to see vacillation and blundering. If we left out of account all larger questions of principle, and considered only how he dealt with the baffling problems of detail which confronted his Government day by day, he would remain a memorable figure in history, since the shrewdness which he displayed was that which is only possible to a man whose whole self is devoted to his task, and for whom petty considerations of vanity or anger or self-advancement have almost ceased to exist. The background of an originally ambitious career and of long practice in the minor arts of political combination from which these qualities emerged in his case enhances their greatness; and the incessant play of light humour in which this personal nobility manifested itself gives it unexampled charm. All this, though we can hardly pause to illustrate it here, meets the eye of anyone who casually turns the pages of a few of the numerous books about him. But all this, if it stood alone, would not suffice to rank him among the great historic exponents of principles of lasting moment. In showing that he does take rank among these, we have to face the fact that, as in lesser things he seemed at the time a blunderer, so in larger things he seemed to many to be without strong principle. His name is linked for ever with what may be called the decisive victory of the principle that all men have rights, yet he was not among the zealots who consecrated their lives to hastening that victory; he had taken no part whatever in the out-and-out "Abolitionist" agitation, and was even unsympathetic towards it. It is true that several courageous acts of his earlier career prove the sincerity of his hatred of slavery, but they were acts of no historic consequence; his only important action in the cause, before he became President and war was thrust upon him, was the negative action of protest against further extension of slavery. Thus he might easily be taken for an opportunist, though an opportunist with a conscience. He really belonged to a far less common type; he was a moderate man, whose moderation goes along with passionate conviction; a philosopher, with the power of cool and detached thought, and with vision reaching far and ranging wide, who yet retained the capacity of instant and decisive action when the rare opportunity came.

Negro slavery in America did not really present a simple issue which could be settled by saying, "This thing is wrong and must be stopped." In the first place, it was bound up with the question whether America could and should continue a single united country; and, in the second place, the legal relation of master and slave was but one element in the condition of the negro and in the whole social problem of the South. Now, Lincoln approached the conflicting requirements of perpetuating the Union, and not perpetuating slavery, with greater comprehension and decision than any other man, and possessed a sympathetic insight into the character and needs of the inferior race in which he stood almost alone among his contemporaries.

It would be granted by everyone that in every critical decision of general policy in these matters, from the moment when the Missouri Compromise[1] was repealed, Lincoln's course was happily guided. Up to the outbreak of war he avoided resolutely any further concession to the principle of slavery, and any provocation to the South, though it was often a matter of delicate discernment to avoid both. In the earlier part of the war he held the North together by holding the balance between those who could fight only for the Union and the crusaders against slavery. He changed the character of the war from one merely for Union into one for emancipation also at precisely the right moment. Thereafter he was equally firm in refusing any compromise of the principles at stake through entangling negotiations with the South, and in discountenancing any spirit of revenge in the treatment of the reconquered States. Such a course might be said to coincide with the course of that sane public opinion which is apt eventually to prevail under popular government, but it would be absurd now to ascribe it, as a distinguished Illinois contemporary of Lincoln's, Senator Lyman Trumbull, ascribed it, to his being "a follower and not a leader in public affairs," "a trimmer, and such a trimmer as the world has never seen." To begin with, no man, not independently anxious for himself to see what is right and do it, has ever yet succeeded in conforming to the hidden movements of sane public opinion. But in Lincoln's case a close study of his life shows that his attitude was the result of principles thought out beforehand with rare thoroughness and consistency.

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[1] See DISCOVERY for July, p. 209.

It is easy to glean and summarise those principles from his speeches, mainly made before his Presidency. They involved no moral lukewarmness about slavery; his hatred of it was none the less passionate because in practice he was restrained by regard for the Union. The Union of America was dear to him, because it represented the only great experiment so far made in popular government, a great country governed "till recently" by a "central idea," of "steady and progressive effort towards the practical equality of all men." It was compatible with loyalty to this "central idea," apart from which he could take no real pride in his country, that the strictest regard should be paid to the legal rights which, from the necessities of their case, the founders of the Constitution had conceded to the slave-owners of the South. But there was danger of going further than this, by allowing slavery to be lawful where it was not already protected by the Constitution, and by conceding in principle that slavery was in itself justifiable, or (even worse) that it was a matter of indifference. Such a policy was to be resisted at all costs, and at any risk to the Union and the existence of the country. If, on the other hand, slavery were placed in such a position that it could not be extended into fresh territory, and that the law and declared opinion of the Union as a whole marked it as wrong in itself, economic and moral causes would force the Southern States to abolish it for themselves in time. Till then any reckless attack on their constitutional rights would lead to the extinction in mere lawlessness of the American experiment in popular government. These beliefs, clearly set out in his earlier speeches on the subject, governed every important action of Lincoln's, from his first participation in the conflict in 1854 till the course of the war had altered the whole situation. Ultimately the blow which was to kill slavery, and which he seems vaguely to have dreamt of as a youth, became in his opinion, as a great lawyer, no breach of the Constitution, but a lawful and necessary act of war in defence of the Constitution. Thereupon he struck that blow. There can seldom have been in all history a statesman whose course was so well thought out on grounds of the profoundest political philosophy or so tenaciously pursued. We can repeat, in a very different sense from that which was first intended, the words of his sometime local rival, "Such a trimmer as the world has never seen."

But there is yet more to be said of that attitude of mind and heart which distinguished Lincoln equally from the ordinary Abolitionist and from the indifferent time-server. His principles were not only clearly worked out, they were envisaged by him in their true concrete application to individuals of flesh and blood.

Most men, who could have said with him, "if slavery is not wrong, nothing is wrong," and who could have exposed, like him, with bitter humour the half-sincere apologies for the system, would have been carried, at least when it came to war, into hatred of the Southern slave-owners. But to Lincoln the guilt of the system seemed not specially theirs; it attached in some sense to all their countrymen, even in a degree to himself. To him it was easy, while insisting with iron rigour on the complete conquest and unreserved submission of the South, to set his foot down on any kind of suggested vengeance, and to preach "we must extinguish our resentments" as the first principle of reconstruction after the war, a principle which far less resolute upholders of the war failed to grasp.

Most men, again, in fiercely contending against a wrong like slavery, would have nursed illusions as to the kind of equality with the white of which the black man was capable, and the benefits which would necessarily flow from liberation. It was not so with Lincoln. He was perfectly well aware of the frequent helplessness of the newly liberated people and the congenital weaknesses of the African. He foresaw the disruption of society and the suffering to black as well as white which war and emancipation would together produce in the South, and he laboured, though in vain, to prevent it. It is well known that he died before he could take any effective steps towards reconstruction in the South, but not before he had given outlines and hints of a policy by which the squalid agony of the years which followed would probably have been much lessened had he lived. But it has been too little noted that, before the Proclamation of Emancipation became not only practicable but necessary, he had used every effort to initiate a policy of gradual and compensated emancipation coupled with education in the Border States, which was likely to have been spontaneously followed by each seceding State as it returned to the Union, and to have placed the negro in a better position than he occupies to-day. He failed because in his day he stood almost alone in what all would now recognise as a true view of the relation between the races. It was a kindlier, not a colder, view than that of any mere wholesale philanthropist. Few things are more moving in his Life than the notices preserved of his actual intercourse with negroes. It must suffice as an illustration that a great negro preacher who came to him, at his earnest desire, to confer with him on some acute point of difference, came away exclaiming in astonishment, "He treated me as a man! He did not let me feel for a moment that there was any difference in the colour of our skins!" How many of us ever produce that effect on a man of swarthier colour?

Thus the full comprehension, which was not at first possible, of Lincoln's main actions and motives produces an effect of intellectual and moral grandeur which his abundant minor failings only endear. If, further, we considered now the quality of his oratory, we should find it to lie, above all, in the sincerity of a man who would not "deceive the people even by a single adjective." His robust devotion to government by the popular vote was rooted in an intense but quite clear-sighted, patient, and disillusioned belief in the good that lies in ordinary people. Lastly, though the once hotly contested subject of his religion lies a little beyond the scope of this article, the truth, as it now stands out, lends a peculiar interest to the deepest of his wholly unorthodox and unconventional thoughts; and we may close our survey of his great work by recalling the words which he spoke, in a rare outburst of confidence, to a friend while his election to the Presidency was proceeding: "If He has a place and work for me, and I think He has, I believe I am ready."

The Discoveries in Crete

By George Glasgow, B.A.

(*Continued from June No., p.* 178)

III

If the nine Minoan periods into which Sir Arthur Evans has divided the Bronze Age in Crete are primarily a fanciful play upon the "nine seasons" of King Minos's reign in Knossos, the system of dating itself is by no means fanciful. It rests on a solid basis. It has been made possible mainly by the fact that the ancient Cretans were seafarers. Cretan products were exported to Egypt, and have been found there alongside Egyptian deposits of more or less known date. Hence a system of sequence-dating can be established. It is obvious that a Cretan vase found side by side with an Egyptian vase of 2500 B.C. belongs to an earlier period than one found with deposits of 1500 B.C. This fixing of landmarks is the first step. The second is to assign to them absolute dates in the terms of our own chronology. Owing to the fact that Egyptian dates (within at least certain limits) are known in terms of our own, and that Egyptian ware has been found in Crete as well as Cretan in Egypt, equation is possible. The chief difficulty is that Egyptian chronology is itself variously interpreted, and one particular version has had to be fixed on for comparison. Three convenient and easily-remembered landmarks have been established:

(*a*) Early Minoan II corresponds to Dynasty VI in the early Dynastic Period of Egypt, *circa* 2500 B.C.[1]

(*b*) Middle Minoan II corresponds to Dynasty XII in the Middle Kingdom of Egypt, *circa* 2000 B.C.

(*c*) Late Minoan II corresponds to Dynasty XVIII in the New Empire of Egypt, *circa* 1500 B.C.

Traces of commercial intercourse overseas can be found as far back as the Neolithic Age. Among the deposits of stone implements in Crete are great quantities of obsidian knives, and the only source of obsidian in the Ægean was the island of Melos. Obsidian is a kind of volcanic glass which flakes off into layers, giving a natural edge. Excavators, who are as childish as most people, have shaved with obsidian knives. It is said that the result has sometimes been a near shave.

It is probable that the Minoan Empire had a navy as well as a merchant marine. Minos was commonly represented as "Ruler of the Waves," and the Greek historians, Herodotus and Thucydides, refer to him as a mythical character celebrated as the first possessor of a fleet. The extent of the Minoan Empire can be gauged by the survival of many trading stations and naval outposts on all the shores of the Ægean, from Sicily in the East to Gaza in the West, which bore the name "Minoa." There was a discreditable chapter, so tradition relates, in the Empire's history. When the King's son Androgeos went to Athens to compete in the games, he carried all before him, and was slain in jealousy; whereupon the all-powerful Minos decreed that seven Athenian youths and seven maidens should be sent every nine years[1] to feed the Minotaur, a monster half man, half bull, which lived in the maze called the Labyrinth. The cruel tribute was paid twice; but on the third occasion, the hero Theseus volunteered to go as one of the victims; and with the aid of Ariadne, the King's daughter, who fell in love with him, he killed the monster. She gave him a sword and a supply of string, which he fastened to the entrance of the maze as he went inside. He was thus able to retrace his steps. Theseus had promised his father, the old King Ægeus, that if he returned alive his ship would show white sails in place of the usual black, so that the glad news could be read in the distance. Whether in his elation or in his hurry to leave Naxos, where (according to the story) he had deserted Ariadne,[2] Theseus forgot his promise, and Ægeus, watching anxiously from the cliffs, and seeing that the sails were black, threw himself in despair into the sea. It was thenceforth called the Ægean Sea.

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[1] As the evidence for this equation is slight compared with that for the other two, it must be accepted with reserve at present as a good working hypothesis.

Minos meanwhile reaped what he sowed. Dædalus, the architect of the Labyrinth, also incurred the King's wrath, and, making himself wings, fled to Sicily. His son Icarus, who went with him, flew too near to the sun; the wax which fastened his wings melted, and he fell into the sea. Minos pursued Dædalus to Sicily, and was treacherously killed. His countrymen went on a punitive expedition to the island, but never returned, and Crete was overrun by strangers.

That is legend. It is a fact, however, that the Minoan Empire did come to a sudden and violent end. Remnants of it—"the men from Keftiu" ("the Back of Beyond"), as the Egyptians called them—landed on the shores of Asia Minor, and finally settled in Palestine as the Philistines of the Bible. The mists of legend are clearing. The huge palace at Knossos is one of the solidest sights revealed. In its bewildering corridors, staircases, and rooms one recognises the Labyrinth itself—a recognition which is confirmed by evidence disclosed within the palace.

IV

The best description of the palace is to be found in Dr. Ronald Burrows's *The Discoveries in Crete*. A shorter description is given by Mr. and Mrs. C. H. Hawes in their admirable little book, *Crete the Forerunner of Greece*. It was built on the slope of a low hill overlooking a secluded valley, three and a half miles from the north shore of the island. While it escaped the notice of pirates, it commanded a view of the Minoan ships in the harbour.

Knossos relied for defence almost entirely on her fleet. In the report of his first year's work (1900), Sir Arthur Evans says[3] that, in contrast to the compact castles of the Argolid, "this Cretan palace, with its spacious courts and broad corridors, was designed mainly with an eye to comfort and luxury." There were minor fortifications, chiefly near the north gate, consisting of a guard-house and bastions, but strategic considerations did not contribute to the main architecture at all.

It is an amazing structure. Built as long before Christ as has the world travelled since, it sounds incredible that it should boast an underground drainage system and other "modern" contrivances. There is no doubt that Cretan architects were men of quality. Mr. H. R. Hall says, in *The Ancient History of the Near East* (p. 47), that, "in comparison with this wonderful building [the later palace at Knossos], the palaces of Egyptian Pharaohs were but elaborate hovels of painted mud. Knossos seems to be eloquent of the teeming life and energy of a young and beauty-loving people for the first time feeling its creative power." The present ruins belong to three structures built at different times. The first was built in M.M. I, or before 2000 B.C., and was burnt down towards the end of M.M. II. It was soon (*circa* 1800 B.C.) rebuilt on a bigger scale, and this building in its turn, some three hundred years later, was remodelled and enlarged. It is this last magnificent palace that predominates in to-day's ruins; in it the Cretans reached the height of their culture. This period, to which belongs what is known as the "Palace Style" in art, was as short-lived as it was brilliant. Within fifty years (so the evidence seems to show) the palace was raided and burnt, and that was the end of Ancient Crete; for the same invaders who sacked Knossos also destroyed the palace at Phæstos.

It is lucky, however, that Minoan libraries were made not of paper, but of clay tablets. They were preserved, not destroyed, by the fire. The baking they then underwent enabled them to survive the dampness of the soil, and they remain to this day, a potential interpreter of many things we do not understand—potential because they cannot yet be read. Scholarship has the hard but fascinating task before it of discovering from these documents the Minoan language. It is lucky, again, that the sackers of Knossos had no use for clay tablets, which accordingly escaped the doom of more "valuable" loot. Dr. Burrows, in *The Discoveries of Crete* (p. 19), quotes the happy analogy of a Reuter telegram which, in reference to the fire at Seville in 1906, announced that "the archives were totally destroyed, but the cash and valuables were saved!"

The outer walls of the palace were mainly built of gypsum, a stone composed of crystals of calcium sulphate. It was so soft that it needed a covering of lime plaster to protect it against the weather. The palace was a square building covering about five acres, or as big an area as Buckingham Palace, and had a flat roof. In shape it was a hollow rectangle with a central court open to the sky. The west wing stood higher up the hillside and had fewer stories than the east wing, whose foundations sloped down to the valley. Beyond the west wing there was another court, and out to the north-west a smaller palace connected with the main building by what Sir Arthur Evans has called " the oldest paved road in Europe." At a point in this road stood the theatre, and there is nothing to prevent us from identifying it with the dancing-place (*choros*) which, so tradition tells us, "Dædalus wrought in broad Knossos for fair-haired Ariadne."[1] It would hold about 500 spectators, who made part or all of the " great throng that surrounded the lovely dancing-place, full of glee," if we may trust the same tradition. No doubt the boxing contests and other forms of sport were held there. The Cretans, to judge by the pictures which have been discovered, were given to strenuous and exciting, possibly cruel, forms of sport. A painted panel depicts a bull-fighting scene. There are two girls and a boy, the girls distinguished from the boy by their white skin, although all three wear the same sort of " cowboy " dress. A bull, head down, is charging one of the girls, who grips its horns in the attempt, apparently, to turn a somersault over its back, a feat which the boy is represented as in the process of accomplishing. He is halfway over, and the second girl stands ready to catch him.

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[1] Other versions say "every year."

[2] The discovery of the forlorn maiden by the god Bacchus is the subject of a famous picture, now in the National Gallery, by the great Flemish artist Rubens.

[3] *Journal of Hellenic Studies*, vol. xx, p. 168.

V

The mass of buildings in the west wing of the palace (for plan of the palace see *Crete the Forerunner of Greece*, by C. H. and H. B. Hawes, p. 48) is divided into two by a long corridor running north and south, that in the east wing by one running east and west. In the west corridor, which is 4 yards wide and 66 yards long, there still stand some of the huge stone vases, " big enough," as Sir Arthur Evans has said, " to hide the Forty Thieves." They were used for the storage of grain, oil, wine, dried fruits, and the like. Under the floors were strong cists, or stone chests, some of them lined with lead, which probably would contain the State treasures. In a narrow corridor to the west of the south main entrance was found the fresco painting of the cup-bearer, an astonishing work of art. It represents a Minoan youth, of stiff but not unpleasing dignity, carrying a gold and silver vase before him. The fresco had fallen into the corridor, where it was found when the connecting wall broke down.

[*Continued on p. 25*[illegible].

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[1] Homer, *Iliad*, xviii. 590.

THE

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The Throne Room of the palace is almost intact. The throne of Minos still stands, carved out of solid stone, and along the wall on either side are the stone benches on which his council sat. Minos was not only the legislative head of the State, he was also the Supreme Judge. So, at any rate, legend indicates, and experience proves that legend is a guide which can be trusted at least to indicate our path. Minos is represented by the legend as holding converse with Zeus every nine years in the Dictaean cave, and as receiving from him, after the manner of Moses in the Old Testament, a famous code of laws which held good throughout the period of the Minoan Empire. And at his death he carried on similar duties in the lower world. Odysseus, during his visit to the shades[1] "saw Minos, the famed son of Zeus, with his golden sceptre, dealing out justice to the dead, as he sat there."

The great staircase by which one descends into the east wing of the palace is surprisingly well preserved, and by 1910 the remains of five flights of it had been restored to their original positions. This staircase, in the words of its discoverer, was traversed "by kings and queens of Minos's stock, on their way from the scenes of their public and sacerdotal functions in the west wing of the palace, to the more private quarters of the royal household." These quarters were built on the south-east slope overlooking the valley of the river Kairatos. The Queen's *megaron*—a sort of hall with columns across it, open at one end to let in the light—was especially luxurious. Its wall paintings, designed in perspective, included a scene of the sea, with its playful fishes, and one of forest life. From the latter the picture of a gorgeously feathered bird has been preserved. The paintings further included a dado of dancing girls.

It is in this section of the palace that the drainage system is best exemplified. As it was lower than the rest of the building, and as the water-supply came from the west, the engineers were up against the problem of preventing flooding—a stiff enough problem for engineers of 4,000 years ago. They solved it by a system of pipes in parabolic curves which subjected the flow to friction. Sinks, lavatories, underground pipes—these are modern things. They nevertheless belonged also to the palace at Knossos. There were workmen's rooms and artists' rooms in the palace; every accommodation, in short, which was necessary for a complete community, for the palace was more or less self-sufficing, like a mediæval castle.

There was another great palace at Phæstos which stands at the opposite side of the island. It was smaller, but in many ways as magnificent, and was roughly based on the same plan of a system of wings grouped round a central court. Much speculation is invited as to what the relationship was between the two cities. The two palaces were built about the same time, possibly (in view of the likeness of style) by the same architects. Both palaces were destroyed more than once. Such are the facts, and the ice is thin for speculation. Were Knossos and Phæstos deadly enemies? The Haweses think[2] that the first palace of Knossos was "attacked and burned at the close of M.M. II, possibly by the rival ruler of Phæstos." Were they connected with each other? Mr. Hall[3] thinks that Phæstos was merely a southern residence of King Minos, who had unified the island under a *pax Minoa*. Legend relates that Phæstos was a colony of Knossos. An obviously significant fact to be remembered in any discussion on this point is that, in sharp contrast to the Mycenæan cities of the mainland, Knossos and Phæstos were in the main unfortified. It is true that M. Dussaud has suggested that Knossos was fortified, but the vast majority of scholars agree that his supposed "fortifications" were nothing of the kind. Dr. Burrows has devoted a special chapter to this point in the as yet unpublished second edition of his book, the manuscript of which he left in my care when he died. His general conclusion is that, while there may have been some sort of fortification in the early days of Crete, Knossos established a peaceful régime when she won her supremacy in L.M. I. In any case, Knossos was not fortified in the days of her empire. She had no fear from within the island, and she had command of the seas.

VI

The buildings of the Stone Age have left hardly a trace of themselves, because they were made of such perishable materials as mud, reed, and wickerwork. Dr. L. Pernier has discovered, under the Minoan palace at Phæstos, a bit of the floor of one of these mud huts. It consists of red clay about 4 inches thick. Some houses, it is true, have been found near the modern Palaikastro, built of unhewn stone, and dating from the Neolithic Age, but they are exceptional. It was only when metal tools were invented that stone could be used generally for building. At the beginning of the Bronze Age the lower walls used to be made of stone, and the upper of sunburnt brick, the latter being further strengthened by wooden stays. Lime plaster was used even then to protect the walls against the weather. Later in the Bronze Age, when the great palaces were built, it became the practice to build foundations and lower walls to a height of about 2 yards of strong limestone blocks, some of them 3 yards long and 1 yard wide, and of gypsum. A protective covering of plaster was then applied.

[1] Homer, *Odyssey*, xi. 568.

[2] *Crete the Forerunner of Greece*. p. 70.

[3] *The Ancient History of the North-East*, p. 45.

The upper stories were generally of wood. Wood was extensively used. Professor Mosso,[1] in reference to a wall of the vestibule at the top of the great staircase at Phæstos, says that " a base of alabaster having been made, holes were made in it to fix slabs of wood all round. These were bound together, and the hollow was filled with a mixture of lime and rubble." Whole tree-trunks were sometimes used as beams, and one can still see the holes in the stone into which they were fixed.

There are many features of these palaces which are worth minute study. In the building of the great palaces it was the practice to prepare the ground with a thick mixture of lime and clay and pebbles. This mixture set so hard that it has now to be broken up with explosives before objects below can be removed. The staircase at Knossos measures nearly 15 yards from side to side, and the steps are 2½ feet wide and hardly 5 inches deep. The most famous steps in Rome were not more than 5½ yards from side to side. The doors of the palace, of which there were many, were made to fit into the walls when open, so as not to interfere with corridor space. At Hagia Triada the drains of 4,000 years ago may still be seen working in wet weather. At Knossos the main drain, which had its sides coated with cement, was more than 3 feet high and nearly 2 feet broad, large enough for a man to move along it ; and the smaller stone shafts that discharged into it are still in position. A little point of detail illustrative of the stage which Knossian architecture had reached is thus described by Dr. Burrows[2]: " Each of them was about 2½ feet long, with a diameter that was about 6 inches at the broad end, and narrowed to less than 4 inches at the mouth, where it fitted into the broad end of the next pipe. Jamming was carefully prevented by a stop-ridge that ran round the outside of each narrow end a few inches from the mouth, while the inside of the butt, or broader end, was provided with a raised collar that enabled it to bear the pressure of the next pipe's stop-ridge, and gave an extra hold for the cement that bound the two pipes together."

There were also baths at Knossos. At any rate, a good many people think they were baths. Professor Mosso thinks they were chapels—a good instance of the excitement which attaches to archæological research. There is no arrangement, says Professor Mosso, for the supply or discharge of water, a provision which many people will agree is necessary for a bath ; moreover, the basin is lined with gypsum, which is soluble in water ; one of them was placed in the Throne Room ; and, finally, they were not private. Professor Mosso's subtle eye even detects an enclosure,

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[1] *The Palaces of Crete*, p. 47.

[2] Ibid., p. 9.

[*Continued on p.* 252

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which he maintains was not put there for the convenience of spectators of the bath, but for a chapel choir. These are attractive arguments, but Dr. Burrows answers quite simply that (1) the gypsum argument is ruled out because it would be covered with plaster; (2) terra-cotta tubs have been found close at hand, and the Knossians might quite well have been content with tubbing instead of plunging into a large tank that needed elaborate pipes; (3) the bath in the Throne Room was used for ceremonial ablutions, for which little water would be needed; and (4) no objects suggesting any cult (such as images or altars) have been found to show that these places were chapels. All this may serve to show what fine sport the archæologist may find in Knossos to-day.

Or take the lighting arrangements There was a system of shafts used at Knossos, at Tylissos (a little palace a few miles west of Knossos), at Phæstos, and at Hagia Triada. The light came down vertically at the back of the room, where the roof had been left uncovered for the purpose, and the floor specially cemented to stand exposure to the weather. Sir Arthur Evans enthusiastically declares that "the light pours in between the columns," and that "in cooler tones it steals into the little bathroom behind"—but on the latter statement Dr. Burrows remarks that it is merely a poetic way of saying that it is very dark there! Dr. Burrows, in fact, connects this darkness with the large number of lamps that have been found. Big marble-standard lamps have also been found which probably held two or even four wicks.

The use of lime plaster on the outer walls gave an opportunity to the Minoan artists, who not only executed fresco paintings thereon, but further fashioned the plaster into relief.[1] "Fresco" paintings are executed as soon as the initial setting of the plaster takes place, and while it is still wet. Brilliant colours were used—red ochre in the E.M. period (made by burning yellow clay), then yellow (from the natural clay) and black; then blue, progressing from a pale greenish tint in M.M. to a dark blue in L.M. The cup-bearer is an example of fresco painting, and the bull's head of high relief; the fresco painters merely attempted an outline and wash of colour in two dimensions, not indicating shades or folds of drapery. The main difference between Cretan painting on wet plaster and Egyptian painting on fine white limestone is that the Cretan gives a more vivid impression of movement, and the Egyptian more detail.[2]

There are many other sites in Crete which cannot be dealt with here—Gournia on the north coast, Palaikastro and others in the east, and Vrokastro. Their main importance lies in their bearing upon Minoan town-planning. Vrokastro has been explored by Miss E. H. Hall, who published her results in 1914.[1] It has a special interest because it belongs to the Iron Age, and shows the inferiority of this age to its predecessor, the Bronze Age. In general the houses in these towns were huddled together with the object of leaving as much ground as possible free for agriculture. They are poor specimens of houses; small two-storied cottages with windows on each side of the door. An interesting point about these Iron Age houses is that they were built on rocky eminences or spurs of mountains—a significant sidelight on the fall of Knossos and the disappearance of her fleet.

(*To be continued*)

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[1] See "Minoan Lime Plaster and Fresco Painting," by Mr. Noel Heaton, *Journal of the Royal Institute of British Architects*, vol. xviii, 1911, pp. 697–710.

[2] See "The Relations of Ægean with Egyptian Art," *Journal of Egyptian Archæology*, vol. i, pt. 3, July 1914, pp. 197–205.

[1] Anthropological Publications of the University of Pennsylvania (Philadelphia).

Sir William Ramsay, K.C.B., F.R.S.

OCTOBER 2, 1852—JULY 23, 1916

The Discoverer of the Rare Gases of the Atmosphere

UNLIKE Sir William Crookes, the subject of our short biography this month was, as he himself has said, predestined by heredity for a scientific career, as his father's people were dyers and his mother's medical men. Although at school he was on the classical side, he took but little interest in the ancient languages which it was his lot to learn, and spent most of his spare time in making experiments in chemistry. In 1871 he obtained his parents' permission to go to Germany to study, and at first intended to enter Bunsen's laboratory, but later decided on Tübingen, where Fittig was attracting students by his researches in Organic Chemistry. On his returning to this country, after obtaining his Ph.D., he went as assistant to the University in Glasgow, and at the early age of twenty-eight was appointed to the chair of Chemistry at University College, Bristol, in 1880. Here his work was associated with that of Dr. Sydney Young, the lecturer in Chemistry, with whom he published a number of researches in Physical Chemistry, having discovered his bent for this branch of the science.

In 1887 he became Professor of Chemistry at University College, Gower Street, an appointment which he held almost to the end of his life; and it was here his life's work was done, not only in research, but also as a great teacher.

Lord Rayleigh had been at work for many years on the exact determination of the densities of the principal gases, and he had encountered certain difficulties which he was unable to explain. The density of nitrogen obtained from the air was not the same as that from ammonia. In 1892 he wrote to *Nature*, asking for suggestions as to the possible cause of this discrepancy. Two years later it was shown that it must be due to some unknown gas in the atmosphere with a density greater than that of nitrogen. On April 23, 1894, we find Ramsay writing to his wife a letter containing the following passage[1]:

"By the way, curiously, I am at work on nitrogen, but not from a commercial point of view; or, rather, Williams is. Nitrogen of air is heavier than nitrogen from ammonia in the ratio of 251 to 250. . . . Now, no one has ever taken all the nitrogen out of the air; or, rather, after all the oxygen has been removed from the air, no one has combined all the nitrogen. It is quite possible that there is some inert gas in nitrogen which has escaped notice. So Williams is at it now combining the nitrogen of the air with magnesium, and seeing if there is anything over—anything not nitrogen. We may discover a new element."

Less than a year later, on January 31, 1895, Ramsay and Rayleigh read a communication to the Royal Society announcing the discovery of this new gas, which they called Argon, and which was so inactive that they could not make it combine with any other element, do what they would. The next day Ramsay was reminded of the work of Hillebrand, who had found gases hidden away in the mineral Cléveite which he had believed to be nitrogen, and which it was now hoped might prove to be a compound of argon with some other element. So Ramsay set to work again to get these gases out of the minerals containing them, with a view to their examination.

On March 24, another letter to his wife tells of the second discovery[2]:

"Let's take the biggest piece of news first. I bottled the new gas in a vacuum tube, and arranged so that I could see its spectrum and that of argon in the same spectroscope at the same time. There is argon in the gas; but there was a magnificent yellow line, brilliantly bright, not coincident with but very close to the sodium yellow line. I was puzzled, but began to smell a rat. I told Crookes, and on Saturday morning, when Harley, Shields, and I were looking at the spectrum in the dark-room, a telegram came from Crookes. He had sent a copy here, and I enclose that

[Continued on p. 254

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[1] NOTE.—The reader is referred to Sir William Tilden's *Life of Ramsay*, published in 1918 by Macmillan and Co., Ltd., from which this letter is taken, as well as the two quotations [2] and [3].

Also to Ramsay's own account of his work on the Rare Gases, in his *The Gases of the Atmosphere* (Macmillan, 1915. 7s. 6d.)

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copy. You may wonder what it means. Helium is the name given to a line in the solar spectrum, known to belong to an element, but that element has hitherto been unknown on the earth. Krypton was what I called the gas I gave Crookes, knowing the spectrum to point to something new. 587·49 is the wave-length of the brilliant line. It is quite overwhelming, and beats argon."

In April 1898, as the result of much thought, Ramsay writes in the *Annales de Chimie et de Physique*[3]:

"I believe, therefore, that an element hitherto unknown should find a place between helium and argon. We have looked for this element in vain. However, we have not given up the search, and if we succeed, the discovery would throw much light on the nature of helium and argon."

A month later the search had been rewarded, for Ramsay with Travers had discovered Krypton ("hidden") in the least volatile portion of a large quantity of liquid air, and only fourteen days after this Neon ("new") was found by the investigators. To cut a long story short, the process was repeated with a still larger quantity of liquid air, with the result that a very small quantity of yet one gas more was discovered. This was named Xenon ("stranger"), and completed the series of gases in the atmosphere, which were all found to be inactive and to have molecules containing but one atom. The work of Rutherford on Radio-activity next attracted Ramsay's attention, and he determined to see whether he could not fix the atomic weight of the "emanation" from radium discovered by Rutherford and Soddy; that is, if it proved to be an element. This involved the manipulation of cubic millimetres of gas only, but in work of this kind Ramsay was a past-master. Soddy and he soon found that the emanation gave rise to Helium, and thus they established definitely the first known case of transmutation. Seven years later Ramsay and Whytlaw Gray actually determined the density of this emanation and showed that it was a true gas, which they called Niton ("shining"). Furthermore, it was shown to fit into the Periodic Table[1] at the end of the series of rare gases already discovered.

Ramsay was a great traveller, and it was his wont to try and learn enough of the languages of the countries he visited, either on pleasure or business, to enable him to converse with the people. Among the journeys he took, mention may be made of one to Stockholm to receive the Nobel Prize. He was, in point of fact, a very notable linguist, and was able to lecture with ease in three languages, and to conduct an international assembly in as many tongues, in itself no mean accomplishment.

E. CAHEN.

Reviews of Books

Applied Eugenics. By P. POPENOE AND R. H. JOHNSON. (The Macmillan Company, 14*s*. net.)

This book gives an excellent account of Eugenics and the relation of this subject to the affairs of everyday life. Mr. Johnson is a professor in the University of Pittsburg; Mr. Popenoe is the editor of the *Journal of Heredity*, which is the organ of the American Genetic Association.

What is eugenics, and what are those people who talk about it trying to do? Eugenics concerns itself with the improvement of the human race. Eugenists wish society to encourage the bringing into being of superior persons, and to discourage that of inferiors. Expressed more fully, the problem of eugenics is to make such legal, social, and economic adjustments that (1) a larger proportion of superior people will have children than at present; (2) that the average number of children of each superior person will be greater than at present; (3) that the most inferior people will have no children; and, finally, that (4) other inferior people will have fewer children than now.

There is a good deal of misconception about the nature and methods of eugenics. Many people do not understand what it is about, nor do they want to. Some imagine it involves the removal of much personal liberty; lethal chambers loom on the horizon. Others oppose it for reasons which are discredited by our present knowledge of biology and sociology. A book like this, which frankly states the case of eugenics, and shows the bearing of the subject on many of the important issues of present-day life, should be widely read. It meets difficulties. It is out to help. The Great War has caused great damage to the sounder portion of those nations engaged in it, and the next generation will have a larger proportion of weaker members than it would have otherwise. Because of this calamity the question of eugenics can no longer be considered merely academic. Fear of racial decline has brought it to the fore. In fifty years from now it will be a very big and important subject.

The opening chapter leaves no doubt upon the mind of the reader of the authors' view upon the relative claims of heredity and environment in producing superior people. They show that changes in a man's surroundings have little influence in changing the nature he has inherited, and that such changes are not transmitted to his children.

The authors then go on to discuss differences among men, the inheritance of mental capacities, the laws of heredity and natural selection. The origin and growth of the Eugenics movement is next fully described, and the extraordinary difficult and delicate problem of restricting the birth of children of physically and mentally inferior persons; and the other problem of increasing the marriage of superiors are very clearly and ably dealt with.

The book is written throughout in a clear style. It is not the least bit too technical for the average reader. The illustrations are good and well chosen.

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[1] DISCOVERY, Feb. 1920, p. 42.

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>
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DISCOVERY

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Editorial Notes

A new journal, the *Psychic Research Quarterly*,[1] has appeared. Its aim is to give in a popular form a reasoned criticism and discussion of spiritualism, telepathy, and other problems of psychical research. It is neither definitely committed nor definitely hostile to spiritualism. Its aim is to get at the truth, or as near as possible to the truth, of these problems, whatever that may be, and to condemn nothing merely out of ignorance or prejudice. The editor himself declares he holds no brief for spiritualism. He thinks, on the contrary, a very strong case can be made out against it. At the same time he believes it is impossible reasonably to maintain that there is no plausible foundation for its doctrines. This is an excellent point of view. If the best obtainable contributions from all sides on the set of problems considered are published in this journal, the reader has every opportunity of forming his own opinion, and this is proposed to be done. Accounts of contemporary researches by reliable investigators and criticism thereon will be included in the journal, and also articles dealing with the relation of Theology, Philosophy, and Psychology to psychical research.

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One of the most interesting articles in this excellent first number is that by Sir William Barrett, F.R.S., on the so-called divining- (or dowsing-) rod. How the dowsing-rod works has always been a puzzle to me. This article does not tell one how, for, it appears, no satisfactory cut-and-dried explanation of the phenomenon is yet forthcoming. But it clears up many doubtful points. It tells us what the water-diviners, or "dowsers," can do, and it suggests a cause of their power without attempting to elaborate details.

* * * * *

A dowser is a man with very special powers. He takes a forked hazel twig, and with the point of the twig upwards and a fork lightly held in each hand, he perambulates in a business-like manner over country in a search for underground water or ore. At certain places, sometimes, there is an unconscious and involuntary movement of the dowser's muscles which causes the twig to twist, and at these places is found the ore or the water which is sought. If any reader has not heard previously of water-divining, or dowsing, we may say that, if he asks us the question, "Do you mean to tell me that a man, by walking about with a piece of wood in his hands and waiting till it twists, can locate water?" our answer is "Yes." The fact seems well established, and examples of it will be quoted below. It is the explanation of the fact that is the difficulty, and which is rightly the concern of psychical research.

* * * * *

A case exemplifying the power of the dowser is given by Sir William Barrett in the following words: "I was anxious to put the dowser to a severe test by asking him to locate places where water would be found and where it would *not* be found. A site was selected in a field on the slope of Carrigoona Mountain [Ireland], where the most shrewd observer could not possibly predict beforehand the presence or absence of underground water at any particular spot. The rock is sandstone and quartzite, and water-springs only occur in a few places. I sent for a good English dowser, Mr. W. Stone, who came over specially from Lincolnshire, where he lived. The field was covered with grass, and the bed-rock was believed to be only a few feet below the surface. The dowser marched to and fro, and fixed on two spots where he said plenty of water would be found within 20 feet from the surface, and another adjacent spot where he said no water would be found.

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[1] No. 1, July 1920. (Kegan Paul, 3*s.* 6*d.* net.)

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"Then I took him to another field on the other side of the mountain; here he declared no water would be found anywhere, the forked twig refusing to move in his hands. A second dowser, a successful amateur, was tried a few weeks later; he knew nothing of the previous dowser's visit. His indications exactly coincided with those of the first dowser. Boring apparatus was obtained and a set of bore-holes were made, first in one field, then in the other. The bed-rock was deeper than we thought, and after boring through 16 feet of hard, dry boulder clay, at the spot where the dowser said water *would* be found, a splendid spring of water was encountered. At the spot, a few yards distant, where the dowser said there was no water, we bored down to the solid rock, and spent a week boring into the rock, but no water was found. At the third place, where he predicted water, we found, on boring, a splendid supply at 18 feet below the surface. In the other field on the opposite side of the mountain, where the dowser declared no water would be found, we bored in several places down to the solid rock, spending a whole month over it, but not a drop of water was to be found anywhere."

* * * * *

Several cases equally interesting are quoted. It appears that the dowser, the possessor of this curious faculty, is a rare bird, although pretenders are abundant. The late John Mullins, a Somersetshire dowser, was one of the most remarkable, and many of his successful locations in the eighties were striking. On several occasions, after large sums of money had been fruitlessly spent in boring for water, Mullins located water with his twig; one of the wells so found has produced no less than 3,000 gallons of water an hour for the last thirty years.

* * * * *

It seems quite certain that this power is genuine. For more than four hundred years stories describing it have been current. It is impossible to ascribe the successes to coincidence, or to explain the matter by saying that the failures are forgotten and the successes alone remembered. Also, we cannot reasonably declare that every man who tells these curious stories is a liar, drawing entirely on his imagination. On the other hand, it is difficult to see what connection there can be between a man with a piece of wood and an underground well. Why of all things should water be located?

Another thing seems fairly certain, and that is, there is no physical action between the water, or whatever it is that is being sought, and the twig. Murmurs in the literature about electrical, thermal, or radio-active forces show merely the ignorance of the writer in the elements of natural science. Something causes the dowser to twist the twig. This involuntary motion may be due to reflex actions, as in the beating of the heart; or may be the result of habit, as in walking; or the result of an emotional disturbance, as in pallor or blushing; or it may be due to some unconscious self-suggestion. The cause is psychical certainly, and not physical, and a working hypothesis which is suggestive rather than explanatory is given as follows by Sir William Barrett:

* * * * *

"The explanation will, I believe, be found to be that the dowser possesses a *supernormal perceptive faculty*, analogous, it may be, to the curious and inexplicable faculties (such as 'homing') which we find in many birds and animals, and our ignorance of which we cloak by calling them 'instinct.' This obscure perceptive power, or instinctive detection of the hidden object of his search, may not excite any consciousness of the fact on the part of the dowser, but it may be adequate to produce a nervous stimulus which will start the involuntary muscular action that twists the forked rod, held by the dowser in somewhat unstable equilibrium.

* * * * *

"As every student of physics knows, there are many physical phenomena which render such a hypothesis by no means improbable. A nugget of gold concealed in its rock matrix, a piece of metal enveloped within the trunk of a tree, a coin swallowed by a child, cannot be detected by any of our senses, but in each case the object is at once perceived if, instead of trusting to our visual perception of luminous rays, we trust to the impression made on a photographic plate or fluorescent screen by the shorter X-rays. Many objects quite opaque to our vision are quite transparent to ether waves, considerably longer or considerably shorter than the luminous waves. Hence, with a suitable detector of those longer or shorter waves, objects which may be completely hidden from our vision can be easily perceived if the object be more or less opaque to these waves. In the working hypothesis I have sketched, the dowser is the analogue of the detector of these longer or shorter ether waves, and the subconscious nervous and muscular disturbance produced on the dowser by the hidden object of his search is the analogue of the molecular disturbance produced in the electric coherer or fluorescent screen or photographic plate."

It is a very remarkable subject, and the results of further research in it will be awaited with interest.

* * * * *

Dr. Dawson Turner, of Edinburgh, has written Lieut.-Col. Crawley, one of our contributors, regarding a point in the early history of wireless telegraphy. On p. 207 of DISCOVERY, Col. Crawley had written: "This coherer action was enunciated by Professor Branly in France in 1890, and a coherer itself was first used for laboratory experiments by Sir Oliver Lodge in this country in 1894." The experiments of Sir Oliver Lodge are usually mentioned as being the first practical work carried out with coherers in this country. As a matter of fact, in 1892 Dr. Dawson Turner showed Branly's coherer experiments in an improved form to Section A of the British Association, and at this and other meetings a little later, made use of the coherer to ring an electric bell and so act as a burglar alarm. Sir Oliver Lodge saw Dr. Turner's experiments at this time, and borrowed some of the powders he was using.

The Housing Problem

By W. S. Purchon, M.A., A.R.I.B.A.

Head of the Department of Architecture and Civic Design in the Technical College, Cardiff

It is perhaps not unfitting that an article on Housing should appear in DISCOVERY, for while housing troubles have been with us a long time, the problem is one of the most serious of those now confronting us, and novel methods are being adopted in tackling it.

For years before the war serious investigators had drawn attention to the facts that large numbers of the houses built in our towns in the first half of the last century, when workers were crowding to the new works and factories, were of such a type and packed so closely together as to be a menace to the welfare of the community, and that most of the dwellings erected in the second half of that century and in the earlier part of the present one, notwithstanding, and in some cases actually because of, increasing stringency of by-laws, were arranged without inspiration and with little or no consideration of the amenities of life.

It is often urged that the people make the slums, but experience of back-to-back houses leads one to marvel at the struggle which many of the tenants are making, against heavy odds, to keep their little homes as clean and pleasant as possible.

The problem was a big one before the war, and unfortunately it was not tackled in a big way. In fact the grave shortage of houses is not only due to the stoppage of building during the war, but also to the rapid decline in house construction which developed in the preceding years.

It is less difficult to grasp the facts if one town is taken as an example, as the figures for the whole country are somewhat bewildering. This town—which need not be named—is more or less typical of many of the manufacturing centres; in some the problem is more serious, in others less. It has a population of about half a million, and contains approximately 100,000 houses. Of these some 16,000 are of the well-known "back-to-back" type, and a further 8,000 are considered by those well qualified to judge to be more or less insanitary, making 24,000 houses which ought to be replaced as soon as circumstances permit. Owing to the two causes previously mentioned, there is an estimated shortage of 6,000 dwellings, and to make provision for the normal growth of population 1,000 new houses are required each year.

In tackling a problem of this kind the wise course is to look ahead, and taking the above figures as a basis, a little simple arithmetic shows that during the next twenty years some 50,000 houses ought to be built in or near that town, while 24,000 of its existing dwellings should disappear in the course of that period. Changes may, of course, take place in the rate of development of any town, and the numbers given may be found to apply to eighteen or twenty-five, instead of to twenty years. Such figures, however, make it clear that our schemes should be on generous lines, that the individual houses should be designed with care and skill, and that considerable forethought should be exercised in deciding the general outlines of town development.

An examination of most of our cities shows that the great growths which took place in the half-century preceding the war were carried out in the main without any comprehensive scheme, have a general effect which is usually most depressing, and consist of houses which are normally more or less inefficient. One remarkable fact is that while English architects are world-famous as house designers, an amazingly small proportion of English houses was designed by them. The folly of this has fortunately been realised at last, and most of the houses which are to be built in the coming period will be the work of skilled designers. In this work there are two main parts—the individual building, and the general scheme of development.

In designing the new houses the first point to be settled is the accommodation which ought to be provided. It is sometimes stated that there is no need to build more of the smallest class of house, as there are plenty of them in existence. It may well be urged, however, that many newly-married couples would prefer to start in a small way, provided they could obtain well-arranged accommodation in reasonable surroundings, and a further consideration is that it is not desirable to condemn the old people, whose children have grown up and married, to the old conditions.

On the other hand, a fair proportion of the largest class of dwelling usually built in housing schemes is required for the larger families. The large living-room was a useful innovation of pre-war days. The family usually spends most of its time—when indoors and not in bed—in the room which has a fire, and it is better that this should be a comparatively large and airy room rather than a cramped and stuffy kitchen. In the case of the larger families a very good case can, however, be made for a parlour in addition to a living-room. To give one reason only, without this room in which the children can do their homework and in which the father can read and prepare his essays, the "open door" to higher education is almost closed, and the Workers' Educational Association is sadly handicapped.

While talking about "open doors" it should be mentioned that if there are two doors in the living-room, they should be so placed that only a small part of the room is crossed in passing from door to door.

For many years the provision of a bath was a vexed question. It is now generally agreed that it is a necessity, and that it is best arranged in a separate apartment. Some argue that it should be on the ground floor, because many workers come home dirty and ought not to go upstairs in that condition. The right line of development appears to be that of providing proper cleansing facilities at the works, and putting the bath on the upper floor of the house, a position which most readers of DISCOVERY have in all probability found very convenient.

The average pre-war small house was narrow-fronted and had a series of back projections which kept light and air from the back room; the newer type of house has a wider frontage, and projections are either entirely omitted or reduced to a minimum. This method of planning gives a maximum of light and air to each room.

In view of the cost of upkeep, the construction should be as sound and as simple as possible. Our faith should not be pinned to any one material, whether it is one which has received the sanction of tradition or one boomed as an innovation by one or other of the daily papers; but we should experiment fully with every available material and any method of construction which seems at all likely to be satisfactory, while old methods should not be "scrapped" merely because they are old.

Everything possible should be done to reduce the labour involved in running a house. While it is wise to provide a picture-rail in the principal rooms, mouldings which collect dust should be eliminated as far as possible, while metal work which requires polishing should be reduced to a minimum. Much can be done by careful planning of the house, and by the provision of skilfully devised fittings and an efficient hot-water supply to the scullery-sink and bath. It is amazing that such a large proportion of our pre-war small houses had no hot-water apparatus.

Electricity will probably be used for lighting in most of the schemes. For cooking, a coal-range in the living-room and a small gas-cooker in the scullery will probably be, on the whole, the best arrangement available for some years. A coal fire will also in most cases be provided in the parlour and in two of the bedrooms. Coal fires have great advantages, but must ultimately be superseded by methods of heating and cooking which do not pollute the air with smoke. One important point is that the ranges and grates should be really efficient. It is not sound economy to save, say, twenty shillings on these fittings if that saving involves the tenant in additional expenditure on an extra ton of coal each year. This comment applies to many other items in house construction. It is obvious that we must keep down first cost as much as possible, but it must be done with an eye on future expenditure. To use a cheap lock, for instance, which ceases to function after a year or so, is extravagance, not economy.

Attention to the above points will lead to the provision of houses which are far more healthy and useful than the average pre-war house, and the employment of skilled architects will also result in houses which are far more pleasing in appearance with little or no additional cost.

While the individual house will thus approximate more nearly in its efficiency to the bicycle, motor-car, and aeroplane, the question of the disposition of the houses on the site must also receive careful attention. The great majority of pre-war houses were all built more or less to the same plan regardless of aspect, with the result that in a large proportion of houses the sun either entered none of the rooms or the wrong ones. This seems a simple, obvious matter, but it is true to say that for the first time large numbers of small houses are being built specially designed so that the sun shall lighten the living-room and be kept out of the larder.

Again, instead of the dreary, monotonous rows of houses which complied rigidly with pre-war by-laws, the new houses are being arranged in short blocks, each usually consisting of four houses, a method which gives a more pleasant and a healthier result.

Owing largely to lack of forethought in the days before the war, unimportant roads and footpaths were often made unnecessarily wide and expensive. Now that schemes dealing with considerable areas are being worked out carefully, much money can be saved and far more pleasing results obtained by making unimportant roads and paths narrow and light in construction. This does not mean that the houses facing each other will be closer together, but that additional space will be available for front gardens and grass margins.

In working out these schemes, shops can be built *as* shops, not as houses which are afterwards converted more or less inefficiently. A shopping centre can in fact be arranged for, and suitable sites can also be reserved for allotments, playing-fields, schools, libraries, churches, etc.

When the house shortage has been adequately dealt with, the existing bad houses can be replaced by proper homes, in some cases on the same sites, but generally in more pleasant surroundings. The sites thus cleared may be used as open spaces, or as sites for works extensions and business premises, and in making these alterations great street improvements may be effected.

In order that these changes may be the most beneficial, the whole problem of the present town or district must be considered carefully, and an outline scheme for its future development worked out.

It has been suggested that some towns are already sufficiently large, and that their future development should be in the form of separate villages organically connected with the towns but separated from them by belts of open country. Whether this suggestion is adopted or not, a carefully-worked-out scheme will give far better results than the haphazard methods of the past.

BOOKS RECOMMENDED

New Townsmen, *New Towns after the War* (J. M. Dent & Sons, Ltd., 1*s*.).
J. S. Nettlefold, *Practical Housing* (Garden City Press, 1*s*.).
Richard Reiss, *The Home I Want* (Hodder & Stoughton, 2*s*. 6*d*.).
Martin, *The Small House* (Alston Rivers, 2*s*.).
Allen, *The Cheap Cottage and Small House* (Batsford, 8*s*. 6*d*.).
Gotch, *The Growth of the English House* (Batsford, 10*s*.).
Unwin, *Town Planning in Practice* (Fisher Unwin, 42*s*.).

A Unique Transmission System

By W. Harold Johnson, M.A.

THE transmission of power has always been one of the most acute of engineering problems. It is not that the transmission in itself offers any insuperable difficulties, but that as soon as one has to turn corners, as one nearly always has sooner or later in any transmission system, there is a considerable loss in efficiency. The steam engine that is generally coupled direct to the useful implement that it operates, whether it be the propeller of a ship, the wheels of a railway engine, or the spindle of an electric dynamo, is much more easily handled than is the comparatively new prime mover that bids fair to oust the steam engine from all the spheres that the older unit has previously occupied unassailed. And the internal combustion engine is above all things primarily suited for use in mechanically propelled vehicles, in which, with the solitary exception of the aeroplane, the turning of corners in the transmission system is a difficulty that has to be encountered and overcome.

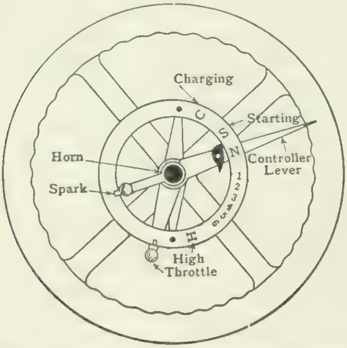
The internal combustion engine relies for its power output primarily on its speed, and consequently there is incorporated in every motor-car mechanism known as the change-speed gear, or simply the gear box, which has the effect of making possible a change in ratio between the engine and road wheels, but at the same time necessitates the turning of corners by the power in its path from engine to back axle. On a normal car the engine makes four revolutions for every single revolution of the back wheel when the car is travelling on what is known as top gear. On bottom gear this number of revolutions is increased up to as many as 16 to 1, and the intermediate gears, that may be one or two in number, generally offer ratios of something like 6·5 and 10 to 1, or if there is only one intermediate ratio this generally is in the neighbourhood of 7·5. The gear box, while quite reliable and satisfactory enough in the hands of a careful and experienced driver, is one of the most delicate components of the car, and is liable to considerable damage as the result of careless handling. Various means have been suggested to enable its entire abolition from the car chassis together with that of the clutch, which is an essential component for the operation of the gear box, although it is constructed as an entirely separate unit from it. Hydraulic transmission systems have been suggested and tried with varying success, the extent of which may be judged from the fact that not a single hydraulic system has ever "caught on" in technical circles.

The idea of using electricity for the transmission has been employed satisfactorily on the Tilling-Stevens heavy chassis for many years, the essentials of this system consisting of an electric dynamo operated by the engine and generating current for a motor which drives the back axle in the ordinary way. But an electric transmission system that is entirely new to this country has recently made its appearance under the name of the Entz, fitted to an American car known in America as the Owen Magnetic, but to be called over here the Crown Magnetic, and in due course, it is hoped, to be manufactured in this country. The transmission itself cannot be described as absolutely new, for the Owen

Magnetic car has been on the American market for some time, and the Entz transmission system has been employed with success on some American battleships. Nevertheless, its commercial application to the propulsion of road vehicles is a new thing over here, and it is from this point of view that I am undertaking this description for readers of DISCOVERY.

To give a full and detailed description of every component of the system in its practically applied form would mean writing a small volume, and consequently this account of the Crown Magnetic car must be regarded as a compromise between a technical description of the leading chassis features and a full exposition of the working of the transmission system. I want to make it clear to the best of my ability just how this transmission system operates, and merely to avoid a charge of obvious incompleteness I intend to refer first—though more or less casually—to such features of the car as would interest the motorist as such.

Enclosed under the bonnet and behind the radiator of conventional design is an ordinary, although large, petrol engine, this having six cylinders with a bore and stroke of 102 × 140 mm., giving a nominal horse-power output of 38, although, of course, the actual output is much in excess of this, for the engine is constructed on the most up-to-date lines and has the overhead valves which have become so popular on car engines as the result of aero experience during the war. The springing of the car is conventional, being by semi-elliptic springs all round; and combined with the comparatively high weight of the vehicle, some $2\frac{1}{2}$ tons, ensures perfect comfort for the occupants over all types of roads. Detachable wheels and electric lighting and starting complete the equipment. And now to deal with its transmission system.



THE CROWN MAGNETIC STEERING WHEEL, SHOWING THE VARIOUS POSITIONS FOR THE CONTROLLING SWITCH.

Firstly, let us be quite clear that we understand the working of the electric dynamo and motor. An ordinary dynamo used for the generation of current consists of a set of electric magnets between the pole pieces of which revolves an armature, i.e. a soft iron core wound with insulated wire. This armature is by some mechanical means revolved on its longitudinal axis between the pole pieces of the magnets, and this revolution and the consequent cutting of the lines of magnetic force from the magnets by the windings of the armature are the immediate cause of the generation of current. Other things take place, of course. There is, for instance, the building up of the current, as it is known, for as soon as the armature begins to revolve, the magnetism of the magnet is increased and armature and magnets work together to give the desired result of a high-current output. These further details, however, are beside our present purpose. What I want to be perfectly clear is that the generation of current depends on the revolution of the armature inside the magnets, in other words, on the *difference* in speed between the two components. From the purely electrical point of view it would not matter whether the armature were revolved mechanically inside the magnets or the magnets were revolved mechanically outside the armature. The same difference in speed would be present, and we should have the same result of the generation of electric current.

To go a step further, suppose we had the two necessary components of a dynamo mounted in correct relation to each other and together mounted as a single unit on a pedestal in such a manner that *both* components were free to revolve. If we now turn either the armature or the magnetos by mechanical means the second component will follow the one that is revolved, through the action of what is known as magnetic drag. In other words, there will be no difference in speed and there will be no generation of current.

So far, so good, and now for the motor. In essentials of construction the electric motor is the same as a dynamo, but instead of one component being operated by mechanical means, current is fed, usually to the magnets, and the armature is thus given a rotary motion by magnetic attraction. In the dynamo, then, we apply mechanical energy and take out electrical, in the motor we apply electrical energy and take out mechanical. With this great difference the two units are the same, and the remarks above as to the relativity between the actions of armature and magnet apply to the motor just as they do to the dynamo. Here we have, then, the principles of the Entz transmission in a nutshell, and we can now proceed to a description of its practical application on the Crown Magnetic car.

Extending forwards from the back axle, which is of normal construction, is a propeller shaft as in any car of standard design. But the forward extremity of the propeller shaft, instead of terminating in the gear box and being continued through it to the clutch, ends in a bearing in line with the engine crankshaft. Just aft of this bearing is an electric armature, and about a foot rearwards of it, also on the propeller shaft, is a second. Positioned round the first armature is a set of electro-magnets bolted to an extension of the engine fly-wheel. Positioned round the second armature is a second set of field magnets attached rigidly to a casing mounted on the main chassis frame. It will be seen that whenever the car moves along the road, whether it be pushed by hand or moves under its own power, the two armatures revolve, as they form an integral part of the propeller shaft. It is also obvious that the first set of field magnets also revolve when the engine is running and under no other conditions, and that the second set of field magnets do not revolve at all.

Assume the car to be standing still with its engine running. The first set of field magnets, known as the rotating field, i.e. those bolted to the engine fly-wheel, are spinning round their armature, which is stationary. There is, therefore, being generated in this unit electric current, for armature and magnets together form a dynamo pure and simple. When the controlling switch on the steering wheel, about which I shall have a word to say a little later on, is in the neutral position, this current is as it were wasted—it is not turned to any practical account; but as soon as the switch is put into the No. 1 position, which is that for moving the car forward, the current generated in the dynamo is passed to the secondary motor, which is thus energised. We have now, therefore, two forces at work, both tending to drive the car forward. The first is the magnetic drag between the rotating field and its armature, the second is the ordinary electric motor action in the secondary motor through the fact that current is being supplied to it from the first unit.

The practical result is that the car begins to move forward, and this *beginning* to move forward is one of the most striking features of the behaviour of this wonderful car on the road. I would defy the most sensitive of individuals to tell from a purely physical sensation with his eyes shut when the car began to move. The beginning is practically imperceptible, and provided the engine be not accelerated, the rate of movement is incredibly slow. As the engine is accelerated, the magnetic drag and the slip between the two units of the first electrical component are increased. Thus the amount of current supplied to the secondary motor is also increased, and the torque or turning moment conveyed to the back wheels is proportionately enhanced.

After the car has gathered speed, the controlling switch is put into the No. 2 position, which is equivalent to a changing up in gear ratio on an ordinary car. Now the magnetic drag between the rotating field and its armature is increased, the slip is decreased, and so is the amount of current supplied to the secondary motor; and so one goes on through the third, fourth, and fifth positions, until when the controlling switch is put in the last or high position the rotating field and its armature are mechanically locked together. There is no slip, and thus no current is supplied to the secondary motor, the drive from engine to back wheel being entirely through the primary unit. But as the armature of the secondary motor is revolving and its magnets are stationary and no current is being supplied to its magnets, this motor automatically becomes a dynamo, and thus generates current which is passed back to the primary motor and serves to ensure the magnetic lock.

It will be seen that at no time is there any positive connection between engine and back axle. There is, of course, an air space between the armatures and their magnets, and the torque of the engine is conveyed to the propeller shaft by magnetic means across this air space. Thus the transmission has what may, for purposes of illustration, be termed an infinite flexibility, and it is impossible to get on the Crown Magnetic car that feeling of jerkiness or unevenness of running that is common on an ordinary car, especially at low speeds and with an inferior clutch or an inexpert driver. Some people who have ridden in the Crown Magnetic car tell me that they seem to experience a sensation of slip all the time, but I have been in the car several times and I can emphatically state that this was not my experience at all. I imagine that in the instances referred to it was a case of auto-suggestion. The critics expected to feel a sensation of slip, they made themselves feel it, and that is all.

To deal with the control of the car from the driver's point of view, this has already been covered in passing in the foregoing description, but may perhaps be advantageously treated explicitly. In the centre of the steering wheel there is a complete circular ring, on the left-hand half of which are mounted the throttle and ignition levers that are found on any ordinary car. It is on the right-hand side that all the Crown Magnetic characteristics are to be found. Here we have a lever rather larger than the ordinary throttle lever, which replaces both clutch and gear lever. The quadrant round which this lever works is marked C, S, N, 1, 2, 3, 4, 5, H. To start the engine, the lever is put in the S position, when the current is taken from the 24-volt batteries that form an integral, although not an essential, component of the system to the primary motor, the armature of which they energise through brushes of the ordinary type, and which then turns the rotating field magnets and so the engine, which is thus started in the ordinary way. The C position is for giving an extra charge to the batteries should this at any time be necessary, although this is seldom likely, as they are continually being recharged when the car is being driven along the road, as is the case on an ordinary lighting and starting set. The N position is the neutral; the other figures on the quadrant have already been dealt with.

There is no clutch pedal, but there are three pedals to be operated by the driver, the left being the brake, the next to it being the accelerator or throttle pedal, and the next the magnetic brake, which, as a matter of fact, may for all intents and purposes be ignored, for it can never bring the car to a standstill and so very few drivers will trouble to employ it. At the side of the driver there are two levers as in an ordinary car, one for operating the hand brake (both hand and foot brakes operate direct on the rear wheels); the other is a gear lever which at first sight seems something of a paradox. Actually, however, it is simply there for engaging a pair of spur pinions to give a reverse gear. When it is required to drive the car backwards, the controlling switch is put in the N position, this gear lever is put into the reverse position, and then the control switch handle is operated just as when it is required to drive the car forwards. Obviously there are as many reverse ratios as there are forward. The whole of the control from the switch on the steering wheel is conducted through a control box constructed on similar lines to that of the ordinary tramcar, this box being mounted immediately above and parallel to that portion of the steering column that goes under the bonnet.

As regards the characteristics of the behaviour of this car on the road, I have already spoken of the most striking, namely, the remarkable smoothness and slowness with which it may be moved from rest. On a test performance the car took no less than thirty-seven seconds to travel its own length. It may be that some readers will think that this performance could be equalled on an ordinary car without, of course, any stops between the time of the first movement of the wheel and the end of the journey, but could it be done on an ordinary car *without a driver*? for that is what can be done on the Crown Magnetic. One may stand at the side of the car, put the control switch in the starting position and then into the No. 1 position, and then one may stand aside from the car and watch it uncannily begin to move forward entirely under its own power and with no one in it! One rather spectacular possibility with the Crown is to start it in this manner, then walk to the front of the radiator, place one's hand and weight on this component and so stop the car. On removing the pressure the car will slowly move forward once again. Another rather striking illustration of the characteristics of this car came to my notice more or less by accident. The magneto switch was out of action and the driver had to stop the engine. He adopted the equivalent procedure of putting on the brakes and letting in the clutch with the engine running slowly, which, of course, is a common method of stopping the ordinary car engine; but whereas with an ordinary car as soon as the clutch is let in the engine stops, with the Crown Magnetic it took something like ten seconds after the controlling switch had been put through the No. 1 as far as to the No. 3 position before the engine stopped.

As to whether Entz transmission will ever become common on cars I hesitate to express an opinion. It certainly has wonderful possibilities, but I rather doubt if its efficiency on top gear is as high as that of the ordinary transmission. Moreover, although experience does not suggest that it will give much trouble or demand more maintenance attention than is the case with a conventional car, it is a fact that should anything go wrong on either of the two motors it is likely to be of such a drastic character that it will be a job for the makers alone to put right. But only experience can tell how the car will turn out after extended use. It has been used on American models for some few years, and no special difficulties have been encountered; and I see no reason why the conservative prejudices of the British public should not be overcome by this wonderfully attractive car, as it has been overcome by other things equally revolutionary in the past. At present the car is made only in the one model, which is not only large but correspondingly high-priced. If, as is to be hoped, it is ever introduced in a medium-priced or light-car form, then there may be a very different story to tell as to the course of its attack on the British market.

How the Turks came into Europe

By F. F. Urquhart

Fellow and Tutor of Balliol College, Oxford

DISCOVERY is a rare adventure in historical studies. When there is a change in the accepted judgment on past events or characters, it is usually the result of a slow process, a work rather of progressive occupation than a raid. Walter Scott and Maitland both belong to the army which has slowly reconquered the Middle Ages, and Cromwell's real character was not established in a day. Occasionally, however, it has been the good fortune of a single man, or even of a single book, to throw such new light on a great event that it is really a discovery. Such a book is Dr. Gibbons of Princeton's *Foundations of the Ottoman Empire.* It was published in 1916, but its lessons have yet to be learnt by those who discuss the Eastern question in the Press. They have no immediate relation to the problems of to-day, but they affect very materially the historical background.

According to the traditional view, the origin of the Ottoman Empire was an invasion of Turks coming originally from Central Asia. In the eleventh century the Seljuks had settled in Asia Minor and parts of Syria. The Crusaders drove them back from the coasts, but they remained in the interior, and were reinforced by fresh immigrants from Turkestan. One of these migrant tribes established themselves east of Brusa in the thirteenth century. With all the vigour of a young people, they gradually took the place of the Seljuks. In the words of Von Hammer, the father of modern Turkish History, " the Empire of the Seljuks broke up, and on its ruins rose that of Osman." At the head of the Turks of Asia Minor the Osmanli pushed across the Hellespont, and, taking advantage of the mutual antagonism of Greek, Bulgar, and Serb, conquered the Balkan Peninsula and then pushed on towards Central Europe. It was the invasion of Europe by a non-European people, by a collection of nomad tribes effectively organised for war breaking in among settled peoples, and setting over them the rule of an alien religion and an alien race.

For this, the traditional story, Dr. Gibbons would substitute something very different. According to him, the small Turkish tribe over which Osman began to rule in 1288 consisted of no more than 400 families. They had occupied for some fifty years a small district east of the Asiatic Olympus, living in friendly relations with their neighbours. Under Osman the tribe became converted from paganism to Islam, and the conversion was followed by a gradual extension westwards. Before Osman's death his people had risen to 4,000 families, but this tenfold increase was almost entirely in districts which had hitherto been part of the Byzantine Empire. The new Osmanli were in great majority " Greeks " who had become Moslems. They preserved many Byzantine customs and used Byzantine law, though the Turkish language prevailed. At first the country districts and then the historic cities of Brusa, Nicæa, and Nicomedia surrendered to the new power. Though Constantinople was so close it gave no help. Distracted by unceasing personal and family feuds, the Palæologi, " the most iniquitous family that ever disgraced the kingly office," made no serious attempt to save the province or the cities. The military defence of the Empire was left to ill-paid and quite untrustworthy mercenaries, often Turks themselves, or to the fitful help received from Genoa or Venice. The Greek Church had hardly more life than the Empire. Its missionary effort had long been exhausted, and its chief interest, and that was passionate enough, lay in the controversy with the Latins. The choice made by the pagan Osman showed which of the rival religions seemed to have more vitality. The new converts to Islam spared the Greeks even the saving grace of persecution. A number of Osman's chief followers became Moslems, but only after they had for years served him faithfully as Christians. The tradition of toleration survived; even as late as 1384 a body of French pilgrims who had returned from the East praised Murad I for his humanity and for allowing the Christians to live under their own laws.

Under Osman's successor, Orchan, the new State began to establish itself permanently in Europe, but only after the Osmanli troops had been for years employed by the Emperor in his civil wars or against the Serbs. Once definitely across the Hellespont, its power advanced with astonishing rapidity. Thirty-five years after the capture of Gallipoli, Serbian independence was destroyed at Kossova. The history of this advance is well known, but Dr. Gibbons emphasises the great part played in it by the Christian Allies and the very numerous converts of Islam. The Sultans never seem to have fought a battle without Christian troops, and they showed a power of turning enemies into allies parallelled perhaps only by the British in India. Just as the Sikhs took our side in the Mutiny within eight years of their annexation, so the Serbians fought for the Turks against the Western Crusaders at Nicopolis, within seven years of Kossova. The friendliness of the Balkan Christians stood the test even of misfortune. In 1402 the great host of Sultan Bayezid, with its Christian contingents, was routed and scattered by Timour at Angora, and the Sultan himself taken prisoner. The relics of the Osmanli army straggled back to the coast. Greeks, Genoese, and Venetian colonists vied with one another in helping them over to Europe, and no attempt was made by the Balkan peoples to combine against the defeated and disorganised Osmanli.

The conclusion seems to be that the so-called " Turkish " invasion was the invasion of a creed and a spirit rather than that of a race, a victory of a young and vigorous faith over one which had unhappily become degenerate. It was only when the Osmanli power had reached the Danube that its armies, which must have largely consisted of Europeans, turned eastward, and reduced the Seljuks of Asia Minor. It was not till the days of Selim, in the early sixteenth century, that Syria and Egypt were overrun and the conquest of Arabia begun. This Eastern expansion and contact with the more fanatical Arabs destroyed in time the tolerant character of the early Osmanli government, but Dr. Gibbons' book is a curious commentary on a manifesto issued some months ago by a number of his most distinguished compatriots in America, in which it was said that " five hundred years ago the Turk entered Europe with a sword, with massacre, with outrage, with pitiless persecution." Our policy towards the Turks should be based on principle and not upon history, but if historical arguments are introduced, they should be real history.

Modern Methods of Weather Forecasting

By Donald W. Horner, F.R.A.S., F.R.Met.Soc.

THE empirical methods that were good enough for our forefathers have, during the past half-century, given place to a scientific system of weather forecasting, based upon synoptic weather charts constructed from information received by telegraph from various stations situated throughout Western Europe, and also from wireless messages from ships in the Atlantic Ocean.

It must be admitted that, notwithstanding all this mass of information and every precaution that may be taken to ensure the correctness of forecasts, there are times when the forecast fails altogether, or arrives too late (in the case of storm warnings) to be of use. Cases of this sort, however, become more rare year by year, *ninety-five per cent.* of the forecasts now made by the British Meteorological Office being correct in most details, the remaining five per cent. only being complete failures. This work, undertaken on a sea-girt island like ours, with only wireless information from moving ships upon which to depend towards the westward, the direction from which most storm-bearing depressions come, compares very favourably with that of the United States Weather Bureau, whose percentage of successful forecasts, with a vast continent covered by a network of local forecast officials, amounts to ninety.

That these few failures may in due time be eliminated is shown by the continuous advances made in recent years.

The Forecast Division of the British Meteorological Office now has its headquarters quite separately at Kingsway, London, W.C.2, the original buildings at South Kensington being used only for climatological purposes. A third branch of the Meteorological Office is the recently-taken-over offices of the British Rainfall Organisation at 62 Camden Square, London, N.W.1, under the able superintendentship of Mr. Carle Salter, F.R.Met.Soc.[1] This is what may be termed a branch of the Climatological Section, as the observations of rainfall, gathered together annually by over 5,000 voluntary observers, are very valuable, and are published annually in volume form in *British Rainfall*.

But in following climatology, we have left our original subject of forecasting.

The name *forecast* was invented by Admiral Fitzroy more than sixty years ago, and it is to the original idea propounded by him at that time that we owe the elaborate system of forecasting by means of synoptic weather charts practised in the present day.

The first forecasts were issued in 1861, and at an even earlier date storm warnings to sailors and fishermen were exhibited on our coasts.

At first these took the form of drums, but these have been superseded by *cones*: the *south* cone, having its point *downwards*, being hoisted on the harbour flagstaff when gales are expected from the south-east, south, south-west, or west, veering north-west; and the *north* cone when the storm is anticipated from the north, north-east, east, or north-west, veering to the northward, but not when backing westward.

The weather maps published daily in certain newspapers are thus prepared:

The state of the weather, sky, and direction of the wind are taken at a large number of stations in the British Isles, the continent of Western Europe, and at the Azores, at 7 a.m. G.M.T. These observations, together with readings of the mercurial barometer in *millibars* and of the thermometer in degrees *absolute*, on being received at the Central Office of the Forecast Division, are plotted by skilled cartographers on charts, forming what is known as a synoptic chart, a term which will be explained later.

These charts are lithographed for the Daily Weather Report, which is sent out to subscribers by post, and at 6 p.m. electros of similar charts are supplied to newspapers willing to give sufficient space to the subject. The papers at present reproducing them are *The Times*, *Daily Telegraph*, and *Morning Post*.

These maps consist of the contour lines of North-western Europe, having the lines of equal barometric pressure (*isobars*) drawn thereon. These isobaric lines are drawn through all places having an equal pressure at the same instant of time; e.g. on June 17, 1919, the evening weather map showed that the barometric reading of 1020 mb. (30.12 in.) started from the coast of France, passed over the Essex side of the Thames estuary, and across London to the Irish Channel, and over to the West of Ireland. The next isobar (1018 mb.) ran across the centre of England and north of Ireland. In this particular case the isobars were fairly wide apart, and light or moderate winds prevailed; except where, off the north-west of Ireland, the 1018 mb. isobar just mentioned closed into a 1016 mb. isobar, which came down from the north to meet it. Here the wind is seen to be blowing in freshly from the westward, illustrating one of the points of the utility of the weather map.[1] Barometrical gradients are measured in hundredths of an inch (or about ⅓ of a millibar) to fifteen nautical miles. According to the "steepness" of the gradient, so will proportionately be the strength of the wind. If the difference between the readings of two barometers (and therefore the denomination of the two resulting isobars) amounts to ·07, the wind will be less strong than on a day when they differ by ·14, and so on in proportion.

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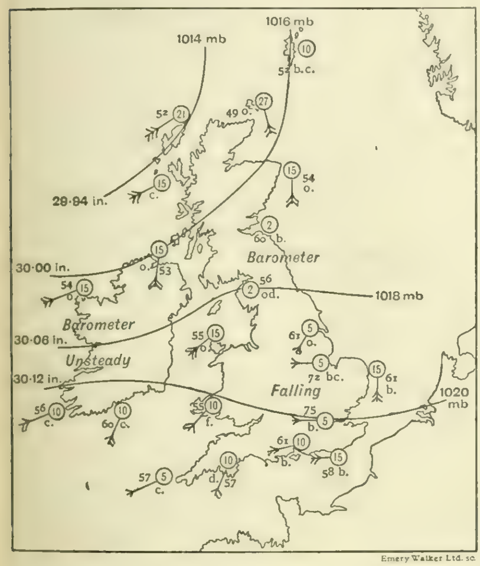
[1] Voluntary observers are always welcomed for this section, and a post-card to the Superintendent will bring a reply as to where fresh rainfall records are most required.—D. W. H.



Emery Walker Ltd. sc.

The following table of gradients is useful:

Gradient	0·5	3	7	15
Velocity of wind in miles per hour	7	25	50	80
Wind	Light breeze	Fresh breeze	Gale	Hurricane

Gradients are calculated in the following manner: If a barometer at one station, which we will call (*a*), reads 29·14 in., and at another station, called (*b*), 29·28 in., station (*b*) being thirty nautical miles distant from (*a*), then the difference in barometer readings is fourteen hundredths (·14) of an inch in thirty nautical miles, or seven hundredths (·07) in fifteen n.m.; hence the gradient is said to be seven.[2]

This system of gradients, in conjunction with Buys Ballot's Law, may be said to be the "backbone" of the synoptic weather chart. This law, which may be called the "Law of Storms," tells us that if we stand with our backs to the wind, low barometric pressure will be to your left hand and high on your right. This is only the case, however, in the northern hemisphere; south of the equator the opposite is true, and when we have our backs to the wind, the low pressure would be on our right hands and high on our left.

For the rest, these weather maps show us direction and force of wind by means of arrows flying *with the wind*, the force being shown by the number of barbs. A calm is indicated thus: ⊙. The figures in the circles at the end of the arrows, i.e. where the point should be, show the velocity of the wind in miles per hour.

The figures just beside the arrows show the temperature at the time of observation. The small letters show the state of the weather in the Beaufort Notation, thus:—

b = blue sky; fine weather.
bc = detached clouds.
c = cloudy generally.
d = drizzling rain.
e = damp; wet air.
f = fog.
g = gloom.
h = hail.
l = lightning.
m = mist.
o = overcast.
p = passing showers.
q = squally.
r = rain.
rs = sleet (rain and snow).
s = snow.
t = thunder.
u = ugly, threatening.
v[3] = visibility; clear horizon.
w = dew.
x = hoar frost.
y = dry air.[4]
z = dust haze; the turbid atmosphere of dry weather, generally associated with E. or N.E. winds.

Since the conclusion of the war the Meteorological Office has come under, and we might say become part of, the Air Ministry, with Sir Napier Shaw, F.R.S., as Director, and Lieut.-Colonel Gold as Superintendent of the Forecast Division. It is quite in accordance with the fitness of things that the Air Ministry and the Meteorological Office should "join hands," so to speak, as in peace, even more than in war, meteorology and aviation must necessarily be of mutual benefit the one to the other; the former showing by means already acquired how the latter may avoid disaster by pointing out unsuitable periods for starting on aerial voyages; whilst the latter, by facilitating the means for the investigation of the upper regions of the atmosphere, will enable the meteorologist to make new discoveries in realms undreamt-of hitherto. So in this way it may be shown that neither science is subservient to the other, but that meteorology and aviation can ever work side by side to the mutual benefit of both.

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[1] Although the wind was generally light inland, on the coasts there were fresh local sea breezes, especially in the north of Scotland.

[2] Inches of mercury can be converted into millibars if we take ·03 in. as equal to one millibar.—D. W. H.

[3] The Beaufort Notation must not be confused with the International Weather Symbols, in which V = rime frost, and the letter *v*, which used to stand for exceptional visibility, was abolished at the International Meteorological Conference in October last, the sign O being substituted for it.

[4] Humidity less than 60%.

The Russians and Their Proverbs

By Louis Segal, M.A., Ph.D.

Head of the Russian Department in the University of Birmingham

The proverbs of a people reflect, to a great extent, their conceptions and sentiments, and allow often a keen insight into national characteristics and mentality. There are, therefore, certain advantages in studying the psychology of a nation from its maxims. The proverbs represent the practical philosophy of the populace, based on the experience of many generations, and express the opinions of a considerable section which prefers to rely on ready-made, current wisdom. All phases of social, political, religious, and domestic life are as a rule reflected in them. But each single saying does not necessarily represent the opinions of the whole nation that produced it. Some may be confined in their circulation to certain trades, professions, and localities, and express the views of those small minorities. Only when a number of proverbs, much in vogue, point in the same direction, can we accept them as representative of national opinion.

There are a number of popular sayings about the proverb itself, all of which show in what great respect it is held by the people in Russia. Sayings such as: "The proverb tells everyone the truth," "No proverb is ever used in vain," "Silly talk is not a proverb," "An old proverb is indestructible," serve as illustrations of this.

A number of Russian proverbs have their equivalents in English and other languages, the thoughts being alike, but the expression differing in form. "More haste, less speed," becomes in Russian "Hurry, and you will become ridiculous." The English "In the land of the blind, one-eyed people are kings," has its equivalent in "Where there is no fish, even crabs are fish."

The Revolution of March 1917 came as a great surprise to everybody who did not know Russia. That such a complicated and extensive system of government should have crumbled down in the course of a few days, involving the loss of a few hundred lives only, was considered nothing less than a miracle. This miracle is to be explained only by the very low esteem in which officialdom and bureaucracy were held. Their corruption and dishonesty were proverbial, and in the day of their trial, not a hand outside of their own ranks was raised in their defence. Sayings such as, "When money speaks, truth is silent," "Money opens all doors," "Don't say a word, let your money speak," "He is right for whom money pleads," are fair comments by the populace on its administrators.

Russians are very religious. There are many proverbs demonstrating their unbounded faith in the Supreme Ruler of the World, and the necessity of prayer on all occasions and in every circumstance. But while religion is held high, the clergy come in for a great deal of criticism. "The eyes of the parson are envious and his hands grabbing," or "The parsons are skinners: they skin the living and the dead," may serve as examples of many disrespectful allusions to representatives of the Church. The monks fare even worse. "Beware of the forepart of an ox, the hind part of a mule, and all sides of a monk," is not in the least complimentary.

Proverbs which indicate the popular view of private property are of interest in view of the attempts made by the Bolsheviks to abolish it, and substitute national ownership of the means of production and distribution. Proverbs such as "Every man is a king in his own house" indicate the complete right exercised by the owner over his property. The landowner had full right to all that came from the land; "Whose land, his corn," or "Whose forest, his timber," show the popular view on the question.

The general view was against leaving money to one's children. The dictum of the late Mr. Carnegie, "I would rather leave my son a curse than a dollar," had several precursors in Russian folk-sayings. "Don't leave money to your sons; the silly will squander it, while the wise can make their own," expresses in somewhat milder form the same idea; while "That is not property which one inherited from one's father, but what one earned oneself," expresses the same idea from a different point of view. The popular belief that what is easily acquired (or inherited or won) brings no luck is also expressed in many sayings.

Unlike in England, the inheritance is as a rule divided equally amongst the sons. "Where there are two sons, all is divided." It is also of interest to note that the youngest, and not the eldest, son inherits the house, making suitable cash adjustments to his brothers.

The saying, "The youngest son remains on the stem," illustrates this.

Private property in personal articles and effects is held in esteem, and no one should violate the eighth commandment. "God will punish him who steals," "Take from others, and you will lose your own," "You will not become rich with stolen property," are popular opinions of the crime against property.

Russians were always an inland race, cut off from the seas by different nations. They had an outlet to the White Sea at Archangel, but that hardly modified the situation. It was not till the beginning of the eighteenth century that Russia secured a footing in the North on the Baltic, and by the end of the same century on the Black Sea in the South. It is therefore natural that the people should have experienced an almost holy dread before that great, mysterious, unknown stranger—the Sea. A number of proverbs point to this fact; "Where there is water, there is misfortune," declares one. Others say: "Far from sea, far from grief"; "Always expect misfortune when sitting on the shore"; "He who has not been to sea knows not sorrow," and so on.

Humility is recognised as a national characteristic in the Russian. Great writers like Tolstoy and Dostoyevsky preached it in season and out of season. The proverb also testifies to its efficacious influence. "Humility pleases God, ennobles the mind, saves the soul, and consoles men," is the popular verdict on that quality.

Russians are justly reputed for being very hospitable. "When a visitor is in the house, God is there," declares one adage. Another stamps the unsociable man as "evil." "He is evil who pays no visits and invites no guests." It is an overbold statement, but no doubt it reflects the general opinion in Russia.

As might well be expected, a large number of maxims reflect the well-founded belief in the therapeutic value of diet and the simple life. "Live wisely and you'll need no doctors"; "He lives long who lives simply," are examples of a large number of sayings dealing with that subject.

Many adages warn against excess in eating or drinking. Some of these express the danger arising therefrom by an arresting comparison: "He who eats when satiated digs his grave with his own teeth," declares one. Another is of the opinion that "One does not die from hunger, but from surfeit," quite oblivious of the fact that hundreds of thousands died in Russia of hunger-typhus during the years when the harvest failed.

A long list of precepts set forth the truth of the good effect on health of a spare diet. "Keep your head cool, your belly in hunger, and avoid doctors, and you'll live to be a hundred," or "Where there is a feast, there is disease"; while another summarises the situation in "Moderation is the mother of health."

The great value of sleep in resting the body is fully recognised in a number of proverbs. One puts it bluntly in: "Sleep is dearer than father and mother"; another pays to sleep the great compliment of comparing it to riches: "Sleep, like riches, the more you have the more you want."

But there is an evident danger in too much sleep. It causes laziness, and may bring about the ruin of the peasant's household. "He who sleeps much will have nought"; "If you lie on the stove you will have to eat bricks," and a number of similar proverbs contain the warning to the peasants of the dangers of sleeping too much.

Idle life is pointed out as the source of ill-health. "The poor man is looking out for disease, while the rich is sought out by it." "Idleness does not feed a man, but only makes him ill," is another truism.

A number of precepts advocate the necessity of being charitable. Charity is considered the essence of true religion. Stories like Tolstoy's *Where Love is, God is*, fully embody this national conception. Also in folk-lore we can trace the same ideal in sayings like, "Don't build a church, support an orphan"; or "Don't build seven churches, bring up seven orphans." One cannot help thinking, had the whole world been permeated by the principles dominating, to a large extent, the illiterate peasantry of Russia, this earth would now be a pleasanter place to live in.

Books of the Month

The following is our monthly selection of books which we commend to the notice of our readers.

Sir Harry. By ARCHIBALD MARSHALL. (Collins, 7*s*. 6*d*.)

Penny Plain. By O. DOUGLAS. (Hodder & Stoughton, 8*s*. 6*d*.)

Foolish Lovers. By ST. JOHN ERVINE. (Collins, 7*s*. 6*d*.)

Eastern Nights and Flights. By "CONTACT" (ALAN BOTT). (Blackwood, 7*s*. 6*d*. net.)

This appeared originally as a serial in *Blackwood's Magazine*.

The Crisis of the Naval War. By VISCOUNT JELLICOE. (Cassell, 31*s*. 6*d*.)

A Constitution of the Socialist Commonwealth of Great Britain. By SIDNEY and BEATRICE WEBB. (Longmans, 12*s*. 6*d*.)

Splendours of the Sky. By Miss Isabel Lewis. (John Murray, 10s. 6*d*.)

An illustrated book on popular astronomy written originally for magazine readers. Very readable and quite up-to-date.

Philosophy and the Christian Religion. By Prof. C. C. J. Webb. (Clarendon Press, 1s. 6*d*.)

A lecture on this subject by the new Oriel Professor of the Interpretation of Holy Scripture, Oxford University.

Relativity. The Special and the General Theory. By Prof. A. Einstein. Translated by R. W. Lawson, D.Sc. (Methuen, 5*s*.)

In this book, which is written for the average reader, Prof. Einstein explains his famous theory. Clearly written and admirably translated.

The Birth of Chemistry

By H. D. Murray

Exhibitioner of Christ Church, Oxford

The science of chemistry may be said to have had its birth in the seventeenth and eighteenth centuries. It is, perhaps, preferable to speak rather of its evolution during this period, since chemistry gradually grew out of the old art of alchemy, which, up to the time of Paracelsus, that is the middle of the sixteenth century, had existed as an art chiefly directed to mean ends and having a close connection with magical practices. This process of evolution began when the old alchemy became raised to a higher status by its alliance with the profession of medicine. Not, however, until nearly 150 years later, when chemistry began to free itself from the limitations imposed upon it by its application to medicine, do we see in it any real growth as a science. From that time up to the latter part of the eighteenth century, when Lavoisier introduced the use of the balance, and so gave to chemistry the form which it now bears, it was dominated by the phlogistic theory. In spite of this, however, the latter period was rich in discoveries and fruitful hypotheses.

In order to understand the world of thought in which the science of chemistry was born, it is necessary to study first the legacy of the alchemists to that world. Their knowledge, which was largely empirical, had its origin in Egypt. The two great theories which coloured all their views were the belief in the transmutation of metals and in the existence of the philosopher's stone. To the latter were ascribed many properties, which varied from time to time, some of them—such as the prolongation of life—partaking of a magical nature. A full account of these properties, stated in less extravagant and obscure terms than those used by Paracelsus and others, is given by Andreas Libavius in his *Alchymia*.

The views of the alchemists as to the constitution of matter were largely founded upon those of the ancient philosophers. The latter recognised in the world four distinct principles—solidity typified by the earth, wetness by water, combustibility by fire, and the gaseous state by the air. The alchemists, however, directed their attention chiefly to the first three principles or elements, using the word probably in a different sense from that used to-day. This may have been due to their very scanty knowledge of gases, which were usually neglected in reactions, and were only classified as combustible and non-combustible. They were all known by the generic term of air. Basil Valentine put forward the view that all substances consist of three elements—sulphur, mercury, and salt—in varying combinations, and the idea received considerable support. Although general knowledge of chemical reactions was small, metallurgy, extraction from ores, and formation of alloys had been more thoroughly studied, both from the utilitarian point of view and as being the readiest point of attack in the problem of the transmutation of metals. In this latter connection, the properties of acids and their action upon various substances were also better known; in aqua regia they thought to have found the long-sought *alkahest*, or universal solvent. There is a tendency nowadays to believe that the knowledge of the alchemists was greater than that formerly attributed to them. Their writings are, however, so very vague and so often full of mystical terms that it is easy, in the light of our present knowledge, to read into some sentence a meaning which, from other sources, we find the writer never intended.

Alchemy may be said to have received the first of the blows which eventually killed it in the teachings of Paracelsus. It is true that he was a firm believer in the transmutation of metals, but we find such alchemistic views occurring even up till the nineteenth century. Dippel, who lived in Berlin early in the eighteenth century, is known traditionally as the last of the alchemists; but the last great chemist to support many of the alchemistic ideas in his teaching was Boerhaave, who died in 1738.

The period dating roughly from the middle of the sixteenth century is known as that of the iatrochemists, and is marked by the attempts made to fuse chemistry and medicine. Paracelsus, and later de la Boë Sylvius (1614–72) and Tachenius, Sylvius' pupil, were the leaders in this attempt. Although we see little advance in actual knowledge during this period, yet chemistry can be said to have continued its evolution, in so far that it was raised from the disrepute into which it had fallen, through the charlatanism of its followers, to the status of a subservient branch of medicine.

The basis of iatrochemistry was the application to the human body of the statement that all substances consist of one or more of three constituents. Paracelsus, for instance, considered that all disease was caused by a preponderance of one constituent. Health could be restored by removal of this excess by suitable medicines. This theory was responsible for a large number of experiments to determine the physiological action of different substances, usually metallic derivatives and alkalies. The word alkali was first used by Van Helmont (1577–1644) in its present sense. Sylvius suggested that the corrosiveness and sharpness of alkalies were due to the fire-stuff taken up during their preparation, this being usually effected by calcination or by boiling with lime. Tachenius first defined a salt as the compound of an acid and an alkali. The iatrochemists were concerned more with the application of chemistry to the workings of medicine than with advance in the science of chemistry. We find, therefore, that any such advance which took place in this period was rather in the recognition of new substances, and an examination of their action upon the human body.

The next distinct period in the history of chemistry dates from the beginning of the eighteenth century, when Stahl (1660–1734) formulated his famous theory of phlogiston. He considered that the property of combustibility is dependent upon a constituent of all combustible bodies, to which he gave the name phlogiston (from φλογίστεω, *set on fire*). This constituent could pass from one body to another; addition of phlogiston to some substances could, for example, be obtained by the action of what we should now call a reducing flame upon them, or by heating one body with another which readily parted with its phlogiston. Accordingly, he believed metals to be compounds of metallic oxides with this hypothetical phlogiston. A difficulty arose when it was found that a body was lighter after the addition of phlogiston than before. This was met by the more ardent supporters of the theory by saying that the laws of gravitation were reversed in the case of phlogiston; in fact, its weight was a negative quantity.

The period of phlogiston contained many great chemists, of whom, possibly, Boyle, Scheele, Cavendish, and Black were the most prominent. Boyle is famous for his work upon gases and the well-known law deduced therefrom. He was, also, the first chemist to define an element as a substance which can enter into combination, but which itself cannot be decomposed. Scheele discovered chlorine and investigated its properties. To Priestley is the credit of many experiments upon gases, in the course of which he discovered oxygen. The work of Black upon the alkaline earths was important since it showed where the difference lay between caustic and mild alkalies. He proved that the former were alkali oxides, and the latter, carbonates. Black also investigated the properties of carbon dioxide given off during these experiments. In view of these advances it is strange to find that, until Lavoisier definitely disproved it, the belief in the conversion of earth into water and similar processes still flourished. In this, and in Stahl's theory of phlogiston, we are reminded of the older theory of four distinct principles or elements in matter, which we find occurring in every part of the world and which seems to have existed from time immemorial.

In spite of the almost universal acceptance of Stahl's erroneous theory, the science of chemistry greatly increased during the period of the phlogistonists. For the first time chemistry was established as a real and independent science. The foundation-stone was laid upon which the structure of chemistry as it is known to-day is built, that structure which the genius of Lavoisier did so much to rear and which, as we regard it, should remind us of the labours of those who worked with such endurance and with so little visible reward.

The Psychological Examinations in the American Army

By Walter Veazie, Ph.D.

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How does the native intelligence of carpenters compare with that of doctors? Is there any psychological basis for the division of society into classes? Is mental retardation ever due to poverty and lack of a chance? These are questions of vital importance to any theory of social reform, and they are questions which have acquired a new significance as a result of the psychological census taken in the American Army.

To classify, conserve, and develop her man-power the army called in those scientists especially concerned with the mind, psychologists and educators, whose privilege it was to examine a large and miscellaneous, if not entirely unselected, sample of the population, and to make a canvass of the country's brain-power such as has never before been taken. Whatever may be our doubts as to the value of the tests in determining individual cases, the summation of their results is both interesting and instructive. These results are now being made public.

The specific problems which the military authorities faced were the selection of the right man for the right job and the disposition of draftees of very low intelligence. In the old army promotion came after long observation. A man rarely got his stripes until well on in his second enlistment period, while a soldier must have served six years as a line sergeant before he was eligible for promotion to ordinance sergeant. In the new army, on the other hand, sergeants were literally made over-night, so that the need of a quick and ready method of judging men was imperative.

FEEBLE-MINDEDNESS: A SOCIAL PROBLEM

The proper disposal of men of very low intelligence was an urgent need. Many draftees of such a degree of feeble-mindedness as to constitute not only useless consumers of food, but a positive menace to military efficiency, were sent home to continue in the simple tasks from which they had been taken, while men of intermediate grade were segregated into special organisations for special work adapted to their abilities.

Feeble-mindedness is a state of arrested mental development, due to an original lack of the power of mental growth beyond a certain level. The primary causes of such arrested development are far from being adequately understood, but an unstable or diseased nervous system in the parents may certainly be considered among the most important.

Having reached a certain stage of advancement, the feeble-minded cease to develop, and this stage cannot be raised by any known methods of education. This fact of the hereditary foundation and apparently irremedial nature of mental deficiency is of the greatest importance in considering problems of education and reform.

Three classes of the feeble-minded are ordinarily recognised: (1) idiots, those persons lacking the ability to protect themselves from ordinary physical dangers; (2) imbeciles, those able to see to their physical wants and do simple, routine tasks, but unable to bear the responsibility of looking after their general welfare or of providing for themselves without constant supervision; (3) morons, or those who, assuming full responsibility for their actions and livelihood, are of inferior judgment and unable to progress in school or industry—the ne'er-do-wells and the dullards.

For the care of idiots and imbeciles society assumes responsibility, and the problem is rather financial than social; but the moron is not recognised either legally, medically, or industrially as being different from the rest of us, and he accordingly constitutes the greater social problem. From among this class are recruited the greatest percentage of chronic failures, of prostitutes, of criminals—those persons unable to judge the natural consequences of their acts. As feeble-mindedness is inheritable, the moron, marrying or otherwise propagating his kind, gives to the country generations of undesirables and paupers, a menace and an expense to the State.

The problem in the army was very similar to that in society in general. Idiots, of course, never leave asylums, but the army did receive many middle- and high-grade imbeciles. They were easily recognised, however, and generally disposed of, although military policy was far from uniform on this point. The real trouble began with the moron. The moron formed a weak link in the organisation; he was unteachable and highly expensive, demanding continual supervision; in actual service he was entirely unreliable.

PSYCHOLOGICAL TESTS

"Early in the emergency," says the report[1] given under the authority of Major Robert M. Yerkes, "it became clear to psychologists in the military service that the fundamental psychological problem of the army is one of placement, and that the most important service psychologists could possibly render would be to assist in so assigning every soldier that his mental (as well as physical) ability should be used to advantage. It was assumed by the psychological personnel that intelligence, alertness, the will to win, enthusiasm, faith, courage, and leadership are even more important than are physical strength and endurance, and that this fact must be scientifically reckoned with wherever a strong military organisation is to be built quickly. Very promptly it became the recognised purpose of army psychologists to assist in winning the war by the scientific utilisation of brain-power. The achievement of this purpose necessitated the preparation of special methods of mental measurement in order that recruits should be properly classified for elimination or assignment to military training."

These special methods of mental measurement, however, are based in principle upon the intelligence tests devised by two French scientists, Simon and Binet, to detect and classify backward school children. Simon and Binet undertook to construct a scale that would measure the native intelligence of any child and indicate whether he were normal, precocious, or retarded, and *to what extent*. By this scale a child would be given a mental age which might or might not correspond to his chronological age.

The principle on which these tests were constructed is as follows: Take the ability to count thirteen pennies. They found by experimenting on Paris school children that most of those six years old could count thirteen pennies, so counting thirteen pennies was accordingly considered a test for six-year mentality. The majority of children of six could also repeat a sentence of sixteen syllables, could correctly name the four principal colours (red, yellow, blue, and green), could follow out three simple directions given together, etc.

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[1] *Science*, 1919, N.S. vol. xlix, pp. 221 *et seq.*

In selecting their tests, Simon and Binet aimed to avoid recording the effects of education and to get at the development of *native ability*. The tests were framed to cover memory, attention, discrimination, reasoning, and other mental processes. That group which was passed by the majority of three-year-old children was taken as measuring a three-year mentality, and so on for all the years up to eighteen, the mental age of a superior adult. If a child five years old was examined and passed the six-year tests (or their equivalent in scattered tests), he was considered as of superior intelligence, being a year in advance of most of the children of his age. On the other hand, if he failed to pass the five-year tests and only succeeded with those for four years, he was backward and called for special attention.

A classification of feeble-minded adults can in this way be made on the basis of mental ages. An idiot may be defined as one with a mental age of two years or below, an imbecile as one with a mental age of at least three years and less than eight years, and a moron as one whose mental age is between eight and twelve.

It was, of course, obviously impossible to give an individual psychological examination to every draftee as he entered our gigantic forces, so the psychologists set themselves the task of adapting the examination to a form that could be given to a large group at one time. Tests similar to those of Simon and Binet were printed on a form to be filled out by the examinee, and the necessary directions were read to large groups of from fifty to several hundred in special buildings or Y.M.C.A. auditoriums.

One difficulty was the large number—larger than was expected—of non-English-speaking and illiterate soldiers who were unable to read or write the tests. This eventuality was provided for by a series of performance tests, corresponding results being arrived at through the subject's performance of acts not requiring language. A collection of these performance tests was also adapted to a printed form, and the directions given through the performance of similar tasks in pantomime by an assistant.

General Results in the Army

The specific uses made in the army of the results of psychological testing need not detain us, especially as they are a matter of controversy. In brief they were: (1) aid in selecting men for special training and for officers' and non-commissioned officers' training camps; (2) standardisation of companies, to prevent one unit of a regiment containing a higher percentage of low-grade men than another; (3) elimination of the very low grade or their assignment to special organisations; (4) special disposition of disciplinary cases.

Beyond these practical applications of psychological ratings in the army organisation, generalisations of possibly wide import as to the intellectual structure of the American people have been revealed. Professor E. L. Thorndike, in his vice-presidential address before the American Association for the Advancement of Science, gave a review of the median scores made by men of different occupation groups (previous to entering the army). The lowest group consisted of farmers, labourers, general miners, and teamsters, while the highest contained army chaplains and engineer officers. Between are ranged, in ascending order, general trades (as carpenters, bricklayers), higher trades (as mechanics, tool-room experts), and clerical occupations (as general clerks, book-keepers, typists, accountants).

This list marks a distinction in intelligence rating between those who work with their hands and those who work with their heads, and indicates that the more intelligent naturally gravitate to office and clerical jobs, whereas the less intelligent choose or stagnate in the trades. As Professor Thorndike remarked, "The matter is one of great importance. In proportion as it is true that the more intelligent men seek clerical work rather than work in skilled trades, an essentially invidious class distinction will tend to have a real basis in fact; and the management of business concerns will tend to fall into the hands of men trained in the office and salesroom rather than in the shop."

A similar classification of army officers of the different corps is presented by Major Yerkes. These officers' ratings are headed by engineers, field-artillery, trench-mortar, and personnel adjutants, and end with medical, supply-train, dental, and veterinary officers.

With regard to the population in general, the percentage of illiteracy was much higher than we had been led to expect. If a man said he had attended school three or four years and could write his name, it has been customary to consider him as literate, but by the time he reaches twenty-one he may be unable either to read or write. On the whole, one who has not attended school beyond the fifth grade is illiterate for all practical purposes. This is particularly true of the negroes, so that companies of the latter were at times 90 per cent. illiterate.

The "average" intelligence of the army proved to be well below fourteen years mental age, although just where it will fall has not yet been made public. The average for illiterates was, of course, below the general average and probably not far from eleven years. About 2·6 per cent. of the total number of men examined gave a mental age *under* ten years, and in this connection it must be remembered that the very lowest were never drafted into the army.

THE NEGRO[1]

"The comparison of negro with white recruits," writes Major Yerkes, "reveals markedly lower mental ratings for the former. A further significant difference based on geographic classification has been noted in that the northern negroes are mentally much superior to the southern."

The results in the case of the negro may revive the discussion of a few years past as to the negro's racial status. Certain anthropologists attempted to show the anatomical inferiority of the negro brain and the general inferiority of the race. Negro children were said to be arrested in their mental development at a lower level than white children, and, after the analogy of the feeble-minded, this arrest was considered inherited and irremedial. Professor Franz Boas, one of America's foremost ethnologists, pointed out at the time the dubious nature of much of this investigation and demonstrated that the status of the negro in America may be quite as probably due to environmental features. "It may therefore well be," he wrote, "that if there is any truth in the retardation and final arrest of development of the negro . . . this may be due to the greater poverty and the more frequent ill-nourishment of the negro child." "We must remember that the negro race in our country has been torn away from its historical surroundings, that it has been placed in a new country, and that in this country it has never been in a position of true independence." A confirmation of Professor Boaz's view would seemingly be indicated by the psychological census. The marked mental superiority of the northern negro is certainly not due to a racial difference, nor is there a greater intermixture of white blood in the northern branch. We can apparently conclude then that, given better social, economic, and educational conditions, the North American negro will become a very different person from what he has been, or been made, in the past.

The negro of standard low intelligence, as he came into the army clinic, gave the impression of having a very different mental make-up than the feeble-minded white. As one examiner put it, the negro seemed "normally abnormal"; he was not peculiar but dull, seemingly at home, and well able to take care of himself in spite of his low intelligence. There was also a much less careful selection among the negro recruits by the draft officials, who sent to the camps negro low-grade imbeciles—candidates for asylums. I saw two with mental ages of four years.

THE NEED OF VARIED TYPES OF EDUCATION

The very varied standards of mental endowment, indicated by the classification of test ratings for the different occupations, would lead us to an educational policy diametrically opposed to the educational levelling universally practised and frequently advocated by politico-educational philosophies. The greater number of our youth to whom educational opportunities are open never proceed beyond the eighth grade or early high-school years, and the reason is probably to be found in the fact that they are not capable of undertaking or adapted to the traditional intellectual discipline. If the average man who will become a carpenter differs in quantity and type of intelligence from the average man who will become an accountant or a clergyman, the former should be given an opportunity to obtain an education beyond the three "R's" adapted to his own mentality. It is particularly important to recognise these differences at the present time, when certain States and Governments are about to make school attendance compulsory up to the age of eighteen years. After a certain stage in the 'teens the youth can no longer be made to conform to the education; the education must conform to its material.

POLITICAL AND INDUSTRIAL CLASSES

Is there any natural basis for the universal division of society into classes? If we accept the results of the psychological investigation in the army at its face value, assume that people for the most part marry within their own class, and remember that mental inferiority is hereditary and with cross-breeding cumulative, we might draw a gloomy picture for the so-called "lower classes," analogous to that drawn by the Austrian economists on economic grounds. There certainly is authoritative evidence—of which certain "poor whites" of the southern mountains may be an example—that a restricted intermarrying group of low stock will maintain its inferiority and even deteriorate. However, as regards strata of society, especially in a country like America, no such conclusions are in the least warranted. Outside of a few would-be blooded aristocrats in certain centres there are no marriage groups, but, on the contrary, a constant movement both up and down. Psychological investigations made in several countries to determine the relative intelligence of children from the different social classes have given results slightly in favour of the "upper classes," but not sufficiently marked to warrant any conclusions respecting the next generation.

However, this phenomenon of social "currents" as well as "classes" indicates a fact which we traditionally hate to face in this country since the advent of Jeffersonianism, namely, that in a cross-section of our population at any given time one will find social and economic strata which are indicative of differences in intellectual endowment more than of family connection. I said, since Jefferson, for the Revolutionary fathers—as we have generally forgotten, thanks to high-school textbooks of American history—took this intellectual stratification for granted, assuming that an intellectually upper class would rule the country to the country's good. A great deal of contemporary political philosophy goes out of its way to denounce this view as well as all other social structures to the point where some of our Bolshevik friends seem to advocate a government by, of, and for the feeble-minded.

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[1] Cf. M. R. Trabue, "The Intelligence of Negro Recruits," *Natural History* (Jour. Amer. Museum), 1919, vol. xix, p. 680.

Future of Psychological Testing

Many, if not all, psychologists entertain no delusions as to the intrinsic value of the mental tests now in use. The tests are in an embryonic state and the results as applied to any particular individual are always open to question. Their use in educational institutions is, nevertheless, continually on the increase, not only for the detection of feeble-minded and backward children in the grades, but for determining specific qualifications. Witness the optional substitution at Columbia University of psychological ratings in lieu of the customary entrance examinations in the case of applicants coming with acceptable papers from secondary schools.

The problem of the psychologist, however, in cooperation with the anthropologist, is much larger than mental tests. It is for him, if possible, to mark the limits and limitations of the classes (not necessarily the present classes) of our population, so that social and political reform can deal with something besides sentiment and humanitarianism. In what directions the results may point it is neither my purpose nor power to indicate, but, to take an example, reformers have failed to recognise that an argument for Government control (or protection) over the relations between employer and employee may be based on the relative mental inability of the latter to deal with the economic situation on a par with the "captain of industry," as well as on the basis of general "cussedness" and class hatred.

Not the least of the psychologist's duties is an eugenic problem, the determination of the causes of feeble-mindedness, its relation to other diseases (such as tuberculosis) in the parents, and its inheritability. In this way he may assist in its elimination or possible alleviation. Our present knowledge on these points is most fragmentary and inaccurate. Psychologists may contribute much towards a better knowledge of the human race, without which reform becomes riot and progress a whirligig.

The Study of Athletics and Sports by the Movies

By Ernest A. Dench

Author of "Making the Movies"

In real life athletes accomplish their feats at such a rapid pace that a close study of their movements is out of the question.

Photographs have been suggested and tried as a way out of the difficulty, but it is seldom possible to catch a motion at the psychological time, while the motions themselves would not be of the continuous variety.

Motion pictures offer an effective solution. To obtain films true to life, they must be taken at the rate of sixteen "frames"—or pictures—to the second. There are sixteen of these frames on a single foot of film, or sixteen thousand in the case of a one-reel production.

Therefore, under these conditions, the study of athletics is just as far off as before. The only solution is to slow up the movements, which may seem an impossible task were not the motion picture so versatile.

Cinematography reverses many things, so a number of athletic games like running, jumping, and throwing the weights, were filmed at the rate of one hundred frames to the second—a feat accomplished by a motor attachment to the camera. In the studio is a peculiar kind of clock called a "chronoscope," and it is introduced in order to show the time which elapsed between each motion. It contains but one dial, which is operated by clockwork. The face is divided up into twenty sections, each one of which represents one-twentieth part of a second. The chronoscope is set in motion immediately the camera man turns the crank, and continues until the motion has been completed. The film, when seen on the screen, is projected at the normal speed. The results amaze, when the two methods are contrasted; although the hurdler travels as fast as an express train, he is made to walk along at the pace of an old man. When he leaps the hurdle, he is as graceful as a bird.

Harvard College, U.S.A., has adopted the film as part of its athletic training. The work is in charge of Percy Haughton, the football coach, who has had films taken of the teams at work. He has already been able to trace the weak points of his men to their source.

In baseball, the New York National League has utilised the motion picture to stamp out all useless motions. With this object in view, pictures of the players in action have been taken. These are diligently studied, and the speed in which amateur and professional pitchers, catchers, batters, and basemen work is therefore available. The method is so scientific that the exact time a pitcher takes in the wind-up, the speed of the pitched ball, the angles assumed by its curving, and how long the batter is in finding out he has banged it and in making a start for the new base, the precise period the catcher takes to recover after taking the pitched ball, and then to run 129 feet along the course trying to put out the runner speeding from the first base to the second—all these things are revealed.

As to horse-racing, a French trainer has discovered that it is instructive to visit the kinema theatre in order to see the races in which one or more of his horses have run.

In 1914 there was a dispute over the Derby. " Bumping " and " boring "—foul play on the part of the jockeys—occurred; but many disagreed with the steward's decision, who stated that it did take place, and disqualified the favourite. The motion picture, however, had recorded all these incidents, and thereby proved its worth as an impartial judge.

In boxing, too, champions have found it instructive to have their efforts recorded on the film, and self-criticise them when later thrown on the screen.

In England, not so very long ago, an attempt was made to instruct the amateur golfer in regard to the correct way in which to play his strokes. Accordingly, several famous golfers posed for a bunch of snapshots, but when these were put on a mutoscope machine in rotation, it was found that they lacked continuity.

But all shortcomings were obviated when J. A. Taylor, five times world's golf champion, consented to give a demonstration for the film, by which it was possible to follow every movement of the body, with the start of the swing back until the follow-through was over. The predominant features of the pictures were the champion's marvellous driving and his excellent " putting " and " stymie " strokes. Several close-up views served to show clearly the right positions the hands and feet should be in.

One peculiar thing about cinematography is that an ordinary quick movement appears ridiculously rapid when the film is shown on the screen. For this good reason, Mr. Taylor did not work with his customary pace, but slowed down in order that his actions would get over effectively. The film, which only took fifteen minutes to show, taught the amateur more than he could have learned in weeks by any other method.

I am also informed, on very good authority, that several professionals, when "off colour," find the motion picture highly instructive.

Tactics Adopted in Filming Wild Birds

By Ernest A. Dench

Author of " Making the Movies "

When we get down to nature, as we often do at vacation time, we can't approach sufficiently near to the wild birds for any length of time to study them at first hand. As soon as we come in sight, the songsters fly off to the boughs of some stately tree.

So when we see on the movie-screen some remarkable close-up views of different birds, we pause to wonder how the camera man got the studies unobserved. Maybe a suspicion of doubt passes through our minds. Well, this article is to assure you that there is no faking—the cinematographer succeeds by reason of his own resourcefulness.

Edward A. Salisbury, who has put America on the natural-history-film-map, recently wanted to secure some snappy views of the eagle, so he climbed up an exceedingly tall pine-tree, struggling gamely with his camera, which turned the scale at eighty pounds. To guard against possible attacks on the part of the mother-bird, he carried a nasty-looking stick. It proved, however, no easy task to fix the camera in the top boughs of this majestic forest tree, so he tried one way after another until the machine would keep in position. When he succeeded in doing this, he had the utmost difficulty in coaxing the young eagles to remain in their nests.

To obtain a film study of herons, he made screens out of vegetation growths picked from a tract haunted by the birds. These screens were so cleverly arranged to match the undergrowth that even Mr. Salisbury, on returning the next morning, wandered for over an hour before he could locate his hiding-place. He was soon rewarded, however, by two male birds appearing, and while they indulged in a scrap *à la* Jack Johnson, he turned the crank of the camera.

Imagine, then, his disappointment, when developing the negative, to find a blade of grass had obstructed the view of the lens.

It is a distinct feather in the cinematographer's cap to " capture " the kingfisher, that shy British bird. I happen, however, to know of one camera man who attempted the difficult stunt. He went about it by studying the haunts of the kingfisher for himself. This completed, he took up quarters in a stream at a place where the water was four feet deep. Over his head and shoulders he placed a large mask formed of tree branches. When a kingfisher ventured within view, he moved cautiously, so as to deceive the bird into thinking that the boughs were being floated by the current.

And where was his camera ? That, let me tell you, was under his sheltering contrivance fixed to an anchored floating base. His first filming effort was a failure, for the camera's clicking frightened the bird away.

But one futile attempt did not daunt this enterprising young man, for he next procured another camera and attached it to the same floating base. Day after day he waited for the regular appearance of his victim, when he turned the handle of the second camera, which was without any film. This went on for seven weeks, at the end of which time the kingfisher had learnt to pay no attention to the working of the motion-picture machine.

All he had to show for his untiring efforts was a strip of film two hundred feet in length. Snappy, it is true, but it was run off the screen in two minutes.

Some British birds are cliff-dwellers, and this adds an element of danger to the work of the motion-picture photographer. He usually works with a tripodless camera, and has himself lowered down a tall cliff on a rope. The extra powerful lenses are handy for approaching the birds at a distance unawares.

Equally tedious to film are those birds that favour the ground for building their nests, for, apart from the fact that considerable skill is required to focus the apparatus in the right-angle, it is hard to "snap" the feathered creatures off their guard.

Rubber Tree Diseases

Rubber shareholders are, as a rule, more concerned with the purely commercial aspect of the industry than with the scientific side, but for those who care for such things there is a wide field of interest opened up by some of the technical features of the industry. How little is really known about the growth and origin of rubber is surprising, and knowledge of the real functions of the rubber tree and the production of latex is still in a very undeveloped condition.

Among the numerous questions that arise in connection with the origins of latex and other fundamental problems of the industry may be asked, "What is the particular function of the latex in the life of the tree ?" The only answer is that nobody knows. That the rubber tree is related to the terpene family and that the production of latex has a family relation with other resinous substances is known, but apart from this the real function of the secretion is still unknown. Yet it is obviously essential that, in the best interests of rubber cultivation, this primary function should be understood. The need for increased research work in an industry which now employs some £80,000,000 of capital is very apparent. Planters are very apt to work by rule-of-thumb methods. How many planters have any real knowledge of the intrinsic differences between good and bad yielding strains of trees at the date of planting ? Yet close research into the qualities which differentiate the good yielders from the bad, with the possibilities of selection which could then be exercised, might well have the effect of doubling the yields from any given area. Not many people outside those immediately interested know that the laticiferous tubes in the cortex of the rubber tree are arranged diagonally, so that the choice of the tapping cut from left to right, or *vice versa*, may make a vast difference in the yield, owing to the number of tubes intersected by the cut.

When the number of diseases and enemies to which rubber trees are subject are considered, the casual observer is inclined to wonder how rubber trees manage to survive at all. It is something like the study of a medical treatise, from which the reader can easily persuade himself that he has symptoms of almost every known complaint. Fortunately, however, as in the latter case, all diseases do not attack every tree or every plantation at once. To-day Brown Bast easily takes first place among the enemies of rubber plantations. So far as the general public is concerned, this is practically a new disease, and it is instructive to note that no reference to it is found even in the later treatises on the subject. In point of fact, however, it has been known for many years, but only recently has attention been drawn to it to any considerable extent. In the old days when plantations were closely planted, it was a simple matter to eliminate altogether trees affected with this fatal disease. With the wider planting now generally practised, however, every tree counts for a tree, and, as every rubber shareholder knows, the question has recently assumed considerable prominence.

The first sign of brown bast is a big increase in the latex yield of the tree affected, but this soon diminishes and ultimately ceases altogether. The bark discolours and hard burrs appear, and, if the disease is neglected, the tree becomes useless. The disease is very prevalent throughout the East, few estates having less than 5 per cent. and some as high as 60 per cent. of their trees affected. Curative methods, such as resting, liming, and manuring, have been tried without success, and the only remedy known so far is that of stripping the bark from the portions attacked, afterwards shading the cambium[1] until a new growth of bark has developed.

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[1] The cellular tissue which lies between the wood and the bark.

It is obvious that a disease of this kind is likely to exert a powerful influence on over-production, and should no remedial measures be found, its increase at the worst might involve wholesale replanting of trees in from fifteen to twenty years' time.

Up to quite recently brown bast was described as a physiological disease of the tree, the term in reality being only a confession of ignorance as to its true nature. It was supposed to be due to the effects of tapping, and has been compared with anæmia in a human being. Recently, however, a mycologist in Sumatra claims to have isolated a definite bacterium to which the disease is due, and should further research support this discovery, the search for a remedy would appear not to be hopeless since the cause is known.

Among other diseases with which estates are troubled may be placed in order, after brown bast, the well-known fomes, ustelina, pink dieback, striped canker, and a new enemy called patch canker, while it is well known that any diseased wood is liable to attacks from white ants. Apart from brown bast, however, which has so far defeated the best efforts, most of these diseases are well understood and can be adequately treated if taken in time.

Sir William Henry Perkin, F.R.S.

MARCH 12, 1838—JULY 14, 1907

The Discoverer of Mauve, the First of the Aniline or Coal-tar Dyes

THE keynote to the life of the discoverer whose short biography we give this month has been sounded by himself in the words "Research was my ambition." Born in London, the son of a builder and contractor, he was educated at a private school and then at the City of London School, being intended by his father for the profession of an architect. While still at school, however, he exhibited an unmistakable leaning towards chemistry, devoting the lunch hour to attending lectures on this subject, not in those days included in the usual school curriculum. At the age of fifteen he entered the Royal College of Chemistry under Hofmann, whose honorary assistant he became two years later. His first piece of research work under this distinguished teacher, though it resulted in failure through no fault of his own, led to the preparation of anthraquinone, the parent substance of alizarin, from anthracene, which in itself would have been no mean triumph had he been able to appreciate the significance of what he had done. It must be remembered that at this time organic chemistry was in its infancy, and there was no theory to guide the worker as to the results obtained in the laboratory. His first successful piece of research was completed in 1855, when he was but seventeen years old, and he was then promoted to the Research Staff under Hofmann. It was here that he formed a friendship with Professor A. H. Church, with whom he afterwards collaborated, and it was while in this position that he made his great discovery of Mauve, and laid the foundation-stone of the coal-tar dye industry. As Meldola has so well expressed it, "Seldom, if ever, in the history of science has the discovery of one chemical compound of practical utility led to results of such enormous scientific and industrial importance as this accidental preparation of Mauve in 1856." This discovery was made by a lad of eighteen. Such an ardent research worker was Perkin that the time spent in Hofmann's laboratory was not long enough, and he accordingly fitted up a room in his father's house at Shadwell, and there pursued his researches, independently of Hofmann, in the evenings and during the holidays. Here it was that he and Church produced a reduction-product of dinitronaphthalene, the first of all the azo-dyes, though the true nature of this substance only became known to the discoverers seven years later, when the first patent was taken out claiming a sulphonated-azo colour in 1863. The discovery of Mauve was an accident. Perkin, in the Hofmann Memorial Lecture, has told us how he was "ambitious enough to wish to work on this subject of the artificial formation of natural compounds," and it was in an attempt to prepare quinine artificially that he got "a dirty reddish-brown precipitate."

Nothing daunted, he tried again with aniline, and this time obtained a very dark-coloured precipitate, which was found on investigation to possess the properties of a dye. The discovery of Mauve diverted Perkin from the field of pure to that of industrial chemistry. He left Hofmann's laboratory and, against his teacher's advice, determined to set up a factory and prepare his new dye on a commercial scale. It is hard to realise to-day what this meant in 1856. Everything was pioneer work. The raw products had to be obtained from coal tar on a manufacturing scale. The kind of apparatus and machinery had all to be invented. This was the first artificial colour factory the world had ever seen, and yet such was young Perkin's faith in his discovery that he induced his father, not only to put up the factory, but to sink practically all his capital in an undertaking which must have seemed to him little short of sheer madness. A site was found at Greenford Green, near Sudbury, and there, in June 1857, building operations were commenced. Six months later the new dye, under the names of "Aniline Purple" and "Tyrian Purple," was supplied to one of the London silk dyers. The difficulties overcome in the production of the dye were as nothing to those still to be encountered in inducing the diffident manufacturer to use it.

The silk dyer, the cotton dyer, and the printer of calico had each to be tackled in turn, and it must be confessed that the French were quicker than the British in grasping the meaning of the new discovery. In a lecture before the Society of Arts in 1868 Perkin tells us of his difficulties: "I distinctly remember, the first time I induced a calico printer to make trials of this colour, that the only report I obtained was that it was too dear, and it was not until nearly two years afterwards, when French printers put aniline purple into their patterns, that it began to interest English printers." Through some technical error in the British patent, they were able to manufacture the dye independently. The name Mauve itself originated in France, and it was the importation from France of calicoes printed with the new colour that made the British manufacturer wake up. The new industry thus created immediately influenced pure science, and even Hofmann himself entered the field of tinctorial chemistry.

Perkin did not allow his interest in the technical side to interfere with his passion for research, and though the far-reaching importance of the discovery of Mauve is apt to eclipse his other discoveries, these nevertheless were great enough to hand his name down to posterity. One of them, in fact, has done so, for the "Perkin Synthesis" by which he was able to prepare coumarin, the odorous substance contained in the tonka bean, still bears his name. It is worth noticing that this was the first artificial perfume to be prepared from coal tar.

With Duppa he carried out researches of the greatest importance synthesising glycocoll, a substance hitherto only known naturally. His synthesis of cinnamic acid from benzaldehyde enabled Baeyer and Caro subsequently to prepare artificial indigo. The discovery of artificial alizarin by Graebe and Liebermann set Perkin to work to find a practical method of manufacturing the dye on a large scale, an effort which was crowned with success simultaneously with his German competitors, Perkin being granted a patent for his process on June 26, 1869, one day after the German patent of Caro, Graebe, and Liebermann had been secured. Artificial alizarin has now completely displaced the natural product and put an end to the madder-growing industry. The Greenford Green Works at once started producing artificial alizarin, first in a small way, and then in ever-increasing quantities, long before the Germans made use of the

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discovery. By 1874 Perkin had acquired what, to his simple requirements, seemed sufficient wealth to enable him to retire, at the early age of thirty-six, from his industrial undertakings. The factory was sold, and he set to work to devote his remaining years to the pursuance of his life's desire, Research.

This loss to industry was a gain to science, and there is little doubt that it contributed greatly to the subsequent transference of the dyeing industry from this country to Germany. In 1881 he opened that chapter of physical chemistry which is inseparable from his name by the discovery of the Magnetic Rotatory Power possessed by some of the compounds he had made.

The celebrations of the fiftieth anniversary of the discovery of Mauve in 1906, when the chemists from all over the world met together to offer homage to the founder of the coal-tar industry, must have been rather a trying ordeal to a man of so simple and retiring a nature as Perkin. After this he went on a tour to America, and on his return was just settling down to resume the peaceful course of his studies when an illness put an end to his career. He died while still at his life's work—Research.

EDWARD CAHEN.

NOTE.—The reader is referred to the obituary of Sir William H. Perkin, by the late Professor Meldola, in the *Journal of the Chemical Society*, 1908, vol. ii, pp. 2214–57, and also to the Hofmann Memorial Lecture by Perkin himself, in the same journal, 1896.

Reviews of Books

Conifers and Their Characteristics. By CHARLES COLTMAN-ROGERS. (John Murray, 21s. net.)

The author of this book is the chairman of the Forestry Committee of the Royal Agricultural Society of England. He has a wide experience of trees and a good knowledge of what he is writing about. One gathers, from a reading of the book, that the author is sagacious, far-seeing, and full of humour. He would be a good man with whom to go on a country walk; a good talker too, we should think. But he writes badly. Indeed, he has such a peculiar way of saying what he has to say that we are afraid a great many readers will not be bothered reading him. This is a pity, but so it is.

The object of the book is to help students and others in identifying the many different species of trees included in the category of the natural order of Coniferæ. Cypresses, junipers, cedars, pines, yews, larches, the silver firs and the hemlock and spruce trees, and others, are all described in detail. The descriptions are on the technical rather than on the popular side. At the end of the book a summary of information is given in tabular form, following which there is a glossary of the technical terms used. This is the strongest part of the book, because it is definite, concise, and in a form that is easily consulted.

One feels about this book that it would be all right if only the author would "cut the cackle and get to the 'osses." He adopts at times an anecdotal, chatty manner, digressing apparently merely to be breezy or to make (quite good) jokes. At times he seems to write in inverted commas. One hardly knows whether the journalese he uses is deliberate or not. Imagine George Augustus Sala trying his hand at a style a cross between that of Henry James and the English schoolboy's crib of Vergil, and you have something similar to that frequently adopted in this book. Listen to this in a book about trees. It is taken from the beginning of the chapter on Hemlock Spruce Firs. It is typical.

> "We who perforce in early days of life sallied or were sent forth from home in quest of knowledge, to drink at the Pierian springs of Greek History within the classical courts of our public schools, may be prone to jump wrongly to a conclusion that the Hemlock tree had some connection with a certain deadly drug, that we were instructed by school-books was meted out to those who were regarded in the light of a social or political inconvenience by the *pro tem.* Government of the day which ruled in mighty Athens. . . . Socrates, whose mission it was to lecture—great Socrates, who adored speaking at all times, and who not only adored speaking, but adorned those to whom he spoke with a cloak of infinite wisdom, was enjoined—even if imperatively, let us hope at least in tones of politeness—by the performing clown of the gruesome scene, at the neurotic moment of his last drink upon earth, to keep silence and hold his tongue, and for no other substantial reason than that it might retard the action of the draught, and thereby involve the executioner in an uncalled-for expenditure in the purchase of more poison drug from the innermost recesses of his private purse!"

When discussing the longest-lived trees, he expresses himself as follows:

> "The Bō tree (*Ficus religiosa*), sacred to Buddha, Prince of Sibbartha in Ceylon, claims an existence of 2,000 years, but, as it is no native, nor even naturalised, subject of Great Britain, it must be at once non-suited here, and any pros and cons, in the nature of evidence adduced, declined politely but firmly with thanks."

At other times the author beats about the bush for quite a time before making a plain statement of fact. This preliminary rigmarole may be quite justifiable in political speeches and in the better-class newspaper advertisement, but it is quite out of place in a scientific book. The author, for example, wishes to say that the common silver fir is one of the finest of conifers. Instead of saying so in plain English, or rather prior to saying so in plain English, he proceeds in this way:

> "'You may tire of mountains and rivers, you may tire of the sea, but you can never tire of trees.'—LORD BEACONSFIELD.
>
> "So spoke the departed statesman (more familiarly known as 'Dizzy') of the Victorian Era.

"There are some of us old enough to recall a cartoon in *Punch* that depicted the eminent statesman swung in a hammock in a tree in his garden, and murmuring self-complacently a measure of an Ariel's spirit song:

"'Dizzily, dizzily let me drowse
Under the shadow of Hughenden boughs'

"Though he, Lord Beaconsfield and ex-Prime Minister of a Victorian age, was probably reposing in Virgilian attitude, after the manner of Tityrus, under the covering of a spreading branch on this particular occasion, we take it that the quoted expression of his untiring admiration for trees referred rather to the trees of landscapes generally than to any tree in particular. Be that as it may, it was a high compliment he paid to them; and if any Conifer deserves its share of the praise bestowed more than other, it is the Common Silver Fir, the mightiest and the highest of them all."

So much for the style of the book. And yet it is crammed with information of the right kind. There is another point. There are not enough illustrations. The addition of pictures of the different trees described would be a great advantage. They would greatly assist those readers who cannot get out and see the trees themselves; also pictures do help to relieve the monotony of a scientific book, and the published price admits of them.

A. S. R.

The New Psychology and Its Relation to Life. By A. G. TANSLEY. (George Allen & Unwin, Ltd., 10s. 6*d.* *net.*)

Mr. Tansley is to be congratulated upon having accomplished a timely and most useful work, and, thanks to his thorough grasp of the subject and his exceptional powers of exposition, he has done it so well that his book should stand, on the lowest ground, as a standard of treatment. In view of the literature which has rapidly arisen concerning psychology, it is at any rate safe to say that Mr. Tansley's book will most assuredly serve as an invaluable primer for some time to come.

The author is a botanist by training and profession, and no doubt the verve and lucidity which he displays, in the handling of a difficult science which is yet in its infancy, may owe something to that holiday feeling which we are expected to find in change of occupation, while it lacks nothing which we should expect from a man whose life-work has been in relation to a more exact and much older science.

We may freely admit that the value of a scientific work should not be prejudiced because it is written in halting sentences or slipshod English, but, just as a worthy picture deserves a good frame, so the value of Mr. Tansley's résumé is enhanced by the purity and ease of his diction.

The scope of the work is defined at the close of his introductory chapter, where he points out that "already great strides have been made towards a self-consistent and illuminating interpretation of the human mind, and the field of future investigation seems illimitable. At the same time it must be recognised that much of this wealth of material is but little developed scientifically, that there

[*Continued on p.* 284

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is still much difference of opinion, and a good deal of room for alternative interpretations. That must be the excuse for the method of this book, which, because it essays in a short space, and perhaps overboldly, a systematic exposition of what appears to the author the essential framework of the subject, is obliged to be *a priori* and dogmatic in some places, and on the other hand to leave many important topics undeveloped or, at most, but roughly indicated. The aim is to present a picture, vaguely sketched in some parts, almost blank in others, but, it is hoped, not too much out of drawing."

The book under review, since its foundation is essentially biological, is necessarily based on McDougall's *Introduction to Social Psychology*, and it owes much also to Trotter's *Instincts of the Herd in Peace and War*, one of the outstanding original contributions to Social Psychology. If we desired to find any ground for adverse criticism, it would be that, if the author is overbold in some directions, he appears to us as being overtimid in others. He seems to us quite unnecessarily reticent on abnormality as dealt with by Dr. Bernard Hart in *The Psychology of Insanity*, more particularly in regard to the split-up of the ego which we find in people who, like Mr. Vale Owen, seem to be honestly unconscious of an easily ascertained fact, which is that the "revelations" which they pass on to us are but revelations of the state of their own minds.

Then, again, when Mr. Tansley approaches the concept of a Supreme Being, we become conscious of an increasing aridity. The essential humidity of the atmosphere has disappeared. We seem to have left arable pasture-land for the desert. He leaves us with the impression upon us, which may well be a false one, that He Whom we call the true God is never more than a creation of the human mind, like the gods of Greek or Roman mythology. Our contention is that many things which have been omitted are well within the scope of this work, although, of course, it is quite within the rights of the author to say "thus far and no farther." The sudden conversion, for instance, of a depraved and drunken man into a sober and useful citizen does not seem to us to be outside the scope of psychology as related to life. So with those whose lugubrious "revelations," if we accept them as Divine, would add a new terror to death, and persuade us that annihilation is the best thing that God can give us. Their subjective nature should be explained to the multitude and to the student, so that the use of "planchette" and the mental operations involved in this and other playthings of materialism run to seed shall be quite understood. We are far from suggesting that this is an unbalanced work. We are, to use the author's expression, merely indicating some of the "blanks." We believe him capable of taking us many steps further. Indeed, if we may parody one of Macaulay's poems, and if we may take the "ranks of Tuscany" as symbolising the possible cavillers, we believe that, if Mr. Tansley decides to emulate mentally the physical exploit of Horatius in "the brave days of old," and will take the plunge, he will not only gain a firm footing on the far side, but we shall find that even "the ranks of Tuscany" will scarce forbear to cheer.

A. H. L.

Peetickay. An Essay towards the Abolition of Spelling.
By Wilfrid Perrett, Ph.D. (Heffer, 6s. net.)

Peetickay is a word the literal meaning of which we, being slow in the uptake, have not gathered from a reading of this little book. But actually it represents a new kind of alphabet which, the author claims, goes a long way in the direction of simplifying spelling.

Spelling apparently is the curse of school-life. Hours and hours which might be employed in training little boys in useful pursuits have to be absorbed in drilling children in the spelling, the idiotic spelling, of many of the words of our tongue. If children only knew, declares the author, what a lifelong mess and muddle they are letting themselves in for when they learn their ABC, they would declare a general strike. Receive, believe, seize, buccaneer, desiccate, chrysanthemum—what a suffering these words have occasioned in us!

The new alphabet proposed in this book contains the consonants of our own, each consonant now, however, being allowed to have one particular sound only. Several new and badly-needed consonants are added to represent sounds for which at present there is no adequate or logical representation. In the new alphabet the vowel-letters are dropped altogether, and replacing them are strokes, mostly straight lines, written in different directions and above or below the line like shorthand signs. For example, w | m ╱, p —, ╲ l g ╲ t ╷ represents "We may, pa, all go too," which students of Pitman's shorthand will recognise as the time-honoured question of page 1 of the handbook in a new form, characteristic of this age. For the sounds of our English tongue (the writer counts only forty of them, a number which very few phoneticians would admit to be adequate) he proposes definite symbols, and as the symbols for the consonants are for the most part those at present in use, and as the slopes of the vowel sounds which he recognises are all formed according to a scientific plan, the complete alphabet as far as it goes is easily understood and learned and should not be quickly forgotten.

When this is done, the spoken language becomes the standard, that is, one spells with the Peetickay alphabet simply as one hears. The surname Cholmondeley, if pronounced Chumley by the Cholmondeleys, is written in Peetickay as Chumley. Menzies may be written in several ways in Peetickay according to the taste and fancy of those who pronounce that surname. Since most words have one standard pronunciation alone—which may be learned from a dictionary or by hearing them pronounced by those who speak English most purely, namely (it is claimed) the inhabitants of Belgravia, Inverness, Dublin, and Wallasey—the writing of English in the new medium should not lead to confusion or to schism.

The value of a scheme of this kind is of course very great if it could be universally adopted. The present generation of little children learning to spell and to read for the first time would do so with very much greater ease than any previous one. The difficulty is with ourselves. To ask us to change the spelling of the whole English language, not gradually, as the Simplified Spelling

Society desires, but by a complete reform, is asking a great deal. And we think this great deal is too much. I know of one way alone by which it might be possible, and that is, that the *Daily Mail* use its front page each day for a month telling its readers what Peetickay is, and thereafter publish its news exclusively in the Peetickay type. Whatever happens, the appeal must be made in some way to everybody. To declare that the present system of spelling is silly, illogical, fatuous, or anything you like to an audience of twenty is not doing any good. With all this we agree—but we do nothing.

Changing the spelling of words is more hopeless than trying to introduce an ideal language. For an ideal language like Ido may exist side by side with our own, but if one thing is certain it is that we will not have simultaneously two ways of spelling.

A man once came to Oxford and suggested to the authorities there that if the High were first of all straightened out and then widened, if a few more colleges were built on the southern side, and if, finally, a mound with a castle upon it were erected on Christ Church meadow to dominate the whole, the High might then have some chance of competing with Princes Street, Edinburgh, in beauty. It was undoubtedly an excellent scheme. Many people told him so. What criticism there was was constructive. The single difficulty was in carrying the scheme out. That was insurmountable.

So we believe it is with new methods of spelling. We are much too attached to the present system ever voluntarily to allow changes to take place.

First of all it is a tremendous innovation, and secondly, rightly or wrongly, we believe that a great deal of beauty, of pleasant associations, and of happy memories are bound up with words as at present we know them. All this would disappear for us if we ceased to spell as we do. But for the sake of the young growing up, should we not be unselfish and give up the old system? As a nation we shall never rise (or fall) to that.

P. K. F.

OTHER BOOKS RECEIVED

Human Efficiency and Levels of Intelligence. By H. H. GODDARD, Director of the Bureau of Juvenile Research of Ohio. (Oxford University Press, 6*s.* 6*d.*)

Life of Sir Jagadis C. Bose, M.A., D.Sc., F.R.S. By PROF. PATRICK GEDDES. (Longmans, 16*s.*)

The Nomenclature of Petrology. By DR. ARTHUR HOLMES. (Murby, 12*s.* 6*d.*)

Discovery in Greek Lands. By F. H. THOMAS, M.A. (Cambridge University Press, 8*s.* 6*d.*)

On Gravitation and Relativity. The Halley Lecture. By R. A. SAMPSON, D.Sc., F.R.S., Astronomer Royal for Scotland. (Clarendon Press, 2*s.*).

Microscopy. Third Edition. By EDMUND J. SPITTA, F.R.A.S., F.R.M.S. (John Murray, 25*s.*)

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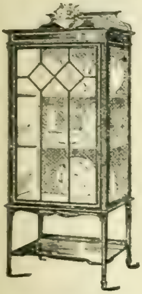

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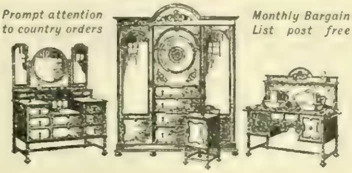

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Editorial Notes

THE eighty-eighth meeting of the British Association for the Advancement of Science met in Cardiff this year. The meetings were well attended, and the discussions on the scientific problems which arose were very good ones. This association, as is well known, serves three main purposes: it gives scientific workers an opportunity for getting in touch with men who are working on allied subjects; it endeavours to encourage research in all subjects; it attempts to make scientific knowledge accessible to the general public. The association has a president, always a distinguished man, who commences the proceedings by delivering an address which sets many people thinking and talking for a considerable time after it has been delivered. Thereafter the association breaks up into twelve sections, each of which has a president, addresses, lectures, and discussions. Interspersed with this work are entertainments and excursions, and the general public of the town are treated to five public lectures.

* * * * *

The president this year was Professor W. A. Herdman, of Liverpool, and the subject of his address was Oceanography. In this address he made two important suggestions: (1) that a department of oceanographic and fisheries research should be established at Cardiff; and (2) that there should be a great national oceanographical expedition, fitted out by the Admiralty, and embracing all departments of the science of the sea—a new *Challenger* expedition, in other words. It is very probable that the second of these will receive the support of the Government, and that not only zoologists, but workers in chemistry, physics, geology, and geography will be among the investigators who go out on that trip. He pointed out that a scientific investigation of the ocean might be considered under two heads, the industrial need and the purely scientific need, and he dealt with both of these in detail. Both needs are very great. There is not a single marine animal, for example, whose mode of life is fully understood. Even common fish, such as the cod and the herring, are in many respects unknown to scientists.

* * * * *

Of course purely scientific work and investigations with a practical end in view do not allow themselves to be kept separate. At times each is of great assistance to the other, and more especially obvious is the contribution of the purely scientific work to that undertaken for a practical and commercial end. It was an investigation of the warm and cold areas of the Faroe Channel which led to the discovery there of the fishing grounds extensively exploited since by British trawlers. Again, when making a scientific study of the deep-sea deposits, Sir John Murray discovered the valuable deposits of phosphates in Christmas Island. We hope to have an article on the interesting subject of oceanographical research in the next number of this Journal.

* * * * *

To turn now to the address[1] of Mr. J. McFarlane, the president of the Geographical Section. Mr. McFarlane discussed in some detail the principles upon which the recent territorial rearrangement of Europe has been based. He considers that Europe will be most stable politically when geographical and ethnical conditions are most in harmony, that is when the people of a particular race live as far as possible inside the boundaries of that race's country, and least stable when boundaries are settled by considerations other than geographical or ethnical. The pre-war Austrian Empire, for example, was such a mixture of political and economic interests that it was bound to come to grief sooner or later, and at the present time it looks as though there were no place at all for it in the new Europe. Again, Italy's northern boundary before the war was unsatisfactory, because much of what was essentially Italy was in Austrian hands. The war settlement, although it has done much, has not straightened out everything. It has established the state of Poland, and this is justifiable on racial grounds, although the country's position geographically is weak principally because there are no natural boundaries to prevent invasion or to restrain the Poles from wandering beyond the racial limits of their country. It has also transferred Alsace-Lorraine to France, and this is justifiable on the ground that the inhabitants are more in sympathy with the French than with the Germans.

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[1] I am indebted to *Nature* of August 26 for the basis of these remarks.—ED.

* * * * *

The treatment of the Hungarian plain, however, is considered to be the most unsatisfactory part of the peace settlement. This is the country of the Magyars, and the partitioning off of parts of it among neighbouring countries is bad, and very likely to lead to trouble in the future. Rumania, for example, by annexing parts of Hungary, has lost her unity of political outlook and her racial homogeneity.

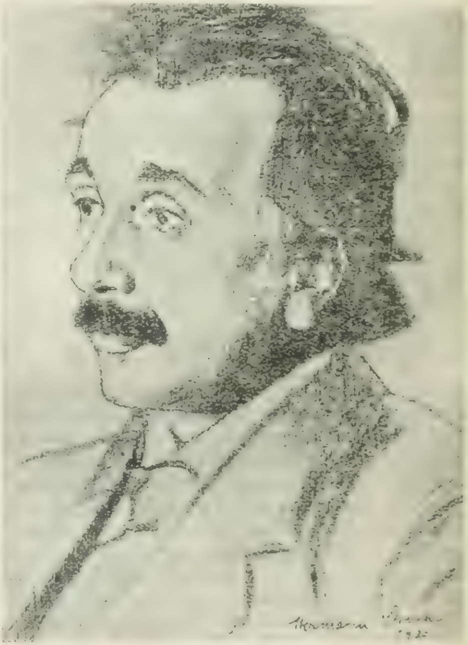
The new state Czecho-Slovakia, which comprises Bohemia, Moravia, and Slovakia, is in many ways the most interesting country in Europe at present. As a whole, however, it is strategically weak, and it does not possess geographical unity. For while Bohemia is geographically individual, and Slovakia strategically strong, Moravia, which unites them, lies across an important route from the Adriatic to the plains of Northern Europe.

* * * * *

Of those who have attempted to set down in writing, for the benefit of the general public, what Professor Einstein's great theory of relativity[1] is all about, it really looks as if Professor Einstein himself were going to come the nearest to success. As this is something which altogether violates tradition, it is a statement of remarkable importance. The tradition is, of course, that a great scientist must be perfectly unintelligible to all but a favoured few. He can explain the universe, or some part thereof, but no one of the general public can grasp a word of that theory at the time it is proposed. Explanations of the theory, when they come at all, come later. They are not given by the Great Man himself. They are the labour of love of the favoured few. Happily the tradition in this case is violated. In this book it really looks as if Professor Einstein had succeeded.

* * * * *

Now the theory of relativity is difficult. All theories are. To understand it really and truly one needs a pretty fair training both in mathematical physics and in philosophy. In addition, a spacious imaginative power, an effort of concentration, and a will-to-understand are not in the way. But the theory is of such importance and interest that an honest attempt to learn what it is about, even in the most elementary way, should be made. Professor Einstein's book is a tremendous help towards this end. He presumes a standard of education corresponding to that of a university matriculation examination, and despite the book's shortness, a fair amount of patience and force of will on the part of the reader. There is, however, nothing in the mathematics or in the philosophical conceptions which need distress anybody unduly, and I feel sure that anyone who gives the book a decent sitting will have a pretty clear and true conception of relativity.



A. EINSTEIN.

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[1] *Relativity.* The Special and the General Theory. By Professor A. Einstein. Translated by R. W. Lawson, D.Sc. (Methuen, 5*s.*)

This book naturally appeared originally in German, and it is largely due to the enthusiasm of the translator, Dr. Lawson, that the book now appears in English in its present form. Dr. Lawson was doing research on radium in Vienna prior to hostilities, and unfortunately was compelled to remain there during the war, and therefore to miss a good deal of the fun and excitement and food which was the happy lot of most of us elsewhere. But he learned German, and this clear and excellent translation is a testimony to his knowledge of that language. He has got Professor Einstein to add an appendix on the experimental confirmation of the general theory,[1] and he has prefaced the volume with a crayon drawing of the author by a German artist, which we reproduce here.

* * * * *

It would be madness for me to attempt to say anything about relativity itself in a few paragraphs except just to indicate in broadest outline the general plan of the book. The book begins by explaining clearly the *principle* of relativity, and why it is necessary to accept it. The author then goes on to show that on the old principles of mechanics the law of propagation of light and the principle of relativity are incompatible, and, as there seems to be no clear way out if either is given up, a dilemma arises. The *special theory* of relativity, which does away completely with this dilemma, is then stated and explained by several carefully chosen illustrations, and the hitherto tacit assumption that the statement of time has an absolute significance, i.e. that it is independent of the state of motion of the body of reference, is shown to be incompatible with the most elementary facts. Next the *general theory* of relativity (of which the *special theory* is merely a special case) is introduced and explained, and the amazing result arrived at that, in general, rays of light are propagated curvilinearly in gravitational fields. Considerations on the universe as a whole arising out of the general theory—the possibility of a finite yet unbounded universe, and the general structure of space—perhaps the most interesting part of all, conclude the book.

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A correspondent who is interested in my remarks on "dowsing" last month sends me his experiences. For some time he has acted as sponsor for a man who lives in the same town, who is a thoroughly good dowser. He is quite convinced that this peculiar power is genuine, and is inclined to think it is probably in some way electrical in origin. A real, thorough, scientific investigation of the whole business in a laboratory has not yet been done. Various tests, however, of different kinds and degrees of difficulty have been set the dowser, and metals have been graded as good, bad, and indifferent, according to the amount of "pull" experienced by him at a distance of three feet. It was found that the dowser is sensitive to gold, silver, copper, and zinc, but not to brass, to platinum, or to steel. He is particularly sensitive to nickel. My correspondent further points out that water-dowsing from the scientific point of view is a by-path, for there the phenomenon is studied under conditions needlessly difficult. What is primarily needed is an investigator to collaborate with the dowser in carrying out a series of experiments under definite laboratory conditions, so that methods and apparatus for measuring the amount and distance of the stimulus and the amount of the response can be worked out as a preliminary to a thorough investigation in detail.

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I have since met this dowser myself, and he did several very interesting experiments for me. He is most sensitive to running water (he is not at all sensitive to stagnant water), then to nickel, gold, silver, and copper in decreasing order. He is sensitive also to certain alloys ; to bronze, for instance, but not to brass. He can tell quite easily whether you have concealed under a hat a sensitive object like a shilling, or something to which he is insensitive, like a piece of brass or a brick. One of his stunts is to say whether or not water is *running* through the water-pipe at a certain place, and this he can do easily, and apparently infallibly. He can tell whether your safe has any valuables (in metal) in it, and he has succeeded in locating hidden safes by his response to the gold and silver inside of them. He finds, however, that he cannot detect things which are placed above him, and also that the presence of a second sensitive substance at a few feet in a certain direction to another sensitive object inhibits the effect. Apart altogether from the scientific explanation of dowsing, and from its utility in locating underground springs, a demonstration of dowsing makes a first-class parlour entertainment.

Was Drake Guilty of Murder?

By Geoffrey Callender

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"A VERY religious man towards God and His houses, generally sparing the churches wherever he came ; chaste in his life, just in his dealings, true of his word, and merciful to those that were under him." Such is the character of Francis Drake drawn by Fuller in his *Worthies*; but it is not an estimate that Spaniards would endorse; and it is a Spanish, rather than a true, portrait of the admiral that our own history-books persistently reproduce. In spite of Sir Julian Corbett's masterly analysis of sixteenth-century international custom respecting maritime reprisals, Drake is still regarded by his own countrymen as a pirate or corsair. Nor is that the end, or the worst, of the indictment. He is accused during the voyage of circumnavigation of emulating the ferocity of Ferdinand Magellan, and under the guise of legal formalities, of murdering his own familiar friend, the accomplished courtier Thomas Doughty.

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[1] See DISCOVERY, February 1920, p. 48.

The voyage of circumnavigation may be thought of as the third canto of what Lope de Vega called the *Dragontea*, or Epic of the "Dragon." Before examining it, however, we must briefly survey the two adventures that preceded it.

Drake made his first bow before a world-wide audience when in 1567–8 he accompanied his kinsman John Hawkins on a trading venture to the Spanish Main. The voyage reached a tragic termination in the Mexican harbour of Vera Cruz, which was then styled San Juan de Ulloa. Here Don Martine Enriquez, Viceroy of New Spain, having given the Englishmen permission to re-equip their ships, basely attempted to sink "without leaving a trace" the helpless vessels he had sworn to protect. And yet, despite his unscrupulous thoroughness, two vessels escaped from the pit of destruction—the *Minion* brought out by Hawkins in person, and the *Judith* by his kinsman Drake.

Hawkins returned to England smarting under his wrongs, and endeavoured at once to procure a royal licence to institute reprisals. But, for reasons which need not be specified here, Elizabeth sternly refused to sanction any scheme of revenge. By enforcing this decision she went a long way towards ending an awkward international situation which Hawkins's voyage had occasioned. It was only by means of letters patent from the Crown that the seizure of Spanish property, as compensation for losses inflicted by Spanish subjects, could by maritime usage have been regularised. The firmness of Elizabeth and her counsellors therefore seemed to bring a painful incident to its close.

But Francis Drake decided otherwise. He resolved to exact from the Spanish Empire complete reparation, even if he had to do so single-handed. Working under a cloak of secrecy, he learnt the Spanish tongue, visited the Spanish West Indian settlements, mixed with his enemies undetected, and discovered all that he needed to know for the schemes that were surging through his brain. He then collected a handful of men, and in a couple of ships set his sails westward-ho for the second eventful chapter of his life. He purposely avoided the baleful shores of Mexico, preferring to exact the restitution he wanted from the harvests of Peru. The treasures of that kingdom (according to his newly bought intelligence) were sent down to the sea from Potosi, Lima, and Quito, and embarked in ships for Panama. Arriving there, they were transferred to *recuas*, or droves of pack-animals, which trotted across to the Atlantic shore, where the glittering commodities were once more re-embarked and conveyed by sea to Spain. There was no traffic through the Strait of Magellan. Every ounce of gold and every uncut emerald passed on mules' backs over the route now followed by the Panama Canal.

Here, then, in bold defiance, Drake stationed himself; and, after hairbreadth adventures which rob romance of its glamour, he ambushed the royal *recuas*, and carried away more wealth than ever figured in an Arabian Night's entertainment. His men filled their bonnets and their boots with gold, then tightened their belts and filled their shirts; and, ere they reached their ships, cast carelessly aside what a king might well have envied. As for the silver, it was nothing accounted of, and was left unregretted beneath the branching coco palms.

Now, whatever may be thought of Drake's conduct on this occasion, there is at least no doubt that in a technical sense he was acting as a pirate; that is to say, he was acting without licence, or letters of marque to cover and legitimise his proceedings. Had the Spaniards caught him, they would have been perfectly justified in delivering him to the familiars of the Holy Office, or hanging him on the nearest tree. Nor did Drake's peril end when he once more dropped anchor at Plymouth. The Spanish representative at the Court of St. James's could easily find out whether Elizabeth had sanctioned the enterprise; and if she had not done so, custom entitled his countrymen to the body of the malefactor. Whether Elizabeth would yield to Spanish pressure and surrender one of her subjects was a doubtful question likely to turn on the exigencies of the moment. The name of Drake was still quite obscure, and the Queen had expressly forbidden any reprisals for what had happened in Mexico. Drake was a man who hardly knew the meaning of fear; but he was not one to accept foolhardy risks. On his return from the Isthmian adventure, he disappeared, and remained in hiding until the storm which he had brewed had somewhat spent its force.

Meanwhile he cherished in his memory the Pisgah-sight which he had seen from the mountains overlooking Panama. Under the guidance of a native chieftain, a *cacique* of the Cimaroons, he had climbed to a platform built in a high tree, and had felt his breath come quickly as he had seen for the first time the league-long glories of the shimmering Pacific. Descending from the eyrie, he had kneeled upon the ground, and prayed God to give him life and strength to drive a furrow through those mighty waters. All with him had been carried away by his enthusiasm; and his second officer, John Oxenham, had clasped him by the hand, and vowed to follow him.

This John Oxenham, so well known to lovers of Kingsley's famous book, is a picturesque and pathetic figure. It was Drake who had put him in mind to sail on the Pacific; and he would have acted more wisely if he had waited a while, until Drake gave the signal to start. Oxenham did not do so. In 1575, three years after the great raid, he set out again for the Isthmus independently. He hid his ship, crossed the mountains unobserved, and set to work in the recesses of the forest to fashion the sort of craft he now required. When she was finished, he floated her successfully down a river, and launched her on the wide Pacific. Good fortune rewarded his toil. Near the Isle of Pearls he captured two barques from the Peruvian port of Quito. The prisoners were many; the spoil was great. Nothing remained but to elude the Spaniards, and carry the treasure home. But Oxenham, with all his courage, lacked the gift of leadership. He allowed his enemies to see which course he was taking; he failed to keep his own men under control. Even his allies, the Cimaroons (who had followed Drake with the fidelity of dogs), turned against him and betrayed him. The few genuine details which survive in the pages of Purchas and Richard Hawkins have been worked up by Kingsley into a highly coloured, but not improbable, narrative. The whole expedition ended tragically; and the Spaniards no doubt felt that they were avenged for the losses which Drake had inflicted three years before. They inquired carefully (this fact should be borne in mind) whether Oxenham had any licence or letters patent from the Queen; and when he failed to produce any, they took summary vengeance. Five boys were spared on account of their youth, and probably sold into captivity. The remainder were executed in batches at Panama; all except Oxenham himself, his master and pilot. The *Dictionary of National Biography* tells us that these three unhappy men were conveyed to Lima, and hanged there the same year. But this information (as will presently be shown), though derived from the best Elizabethan sources, is none the less incorrect.

Towards the close of 1577 Drake set out on his third adventure—the voyage of circumnavigation. Not that his plans at starting involved a circuit of the globe. What he proposed was to penetrate into the Pacific (as he had promised himself in Darien), and return again, if Providence permitted, by whatever route seemed to offer the best chance. There is no need to linger over the details of his programme once the Pacific was reached. It was the spirit of adventure that actuated him; and to this he doubtless added the expectation of further reprisals, and perhaps a faint hope that he would be able to find an entirely new route to the Indies.

Oxenham had reached the Pacific by way of Darien; but Drake proposed to utilise the Strait of Magellan. This sounds a simple enough project to-day, but in 1577 the attempt was one which none but the boldest would consider. Sebastian Cabot had attempted to force the Strait, and failed. Amerigo Vespucci could not even find it. Del Cano, who brought home the remnants of Magellan's expedition, found the passage again with Loaysa in 1525; but neither Loaysa nor Del Cano returned alive. Henceforth the mysterious water-gate could not have been more religiously avoided if it had been the portals of Dante's Inferno. The tortuous passage beyond the gate was known to be 450 miles long, with inhospitable precipices on either hand, and baffling airs that held a ship captive. In the language of the time it was said to be the link between the "North Sea," the ocean of the Old World, and the "South Sea," the ocean of the New. In its swirling eddies, it was thought, the waters of the Atlantic and the waters of the Pacific found their only point of contact. Above the Strait was the great land-mass improperly christened after Amerigo; and below it, stretching away to the "Pole Antartick," lay the corresponding mass of an imaginary continent, *Terra Australis Nondum Cognita.*

All this Drake knew and faced without quailing. Like Ulysses of old, he was cheerfully prepared to go down to the mouth of Hades. But it was another matter to induce ignorant and superstitious mariners to follow him: and he did not consider his preparations complete until he had persuaded some of the best gentlemen in the land to join his company and leaven the lump. Of noble volunteers by far the most important was Thomas Doughty, whose bravery, learning, and charm of manner endeared him to Drake above all who volunteered.

It was vitally important to keep the Spaniards in ignorance of what was afoot; for a hint of Drake's scheme would enable them to post a fleet at one end of Magellan's Strait, and deny him all ingress into the Pacific. Drake himself was a past-master of the art of camouflage; and, when at last he set sail from Plymouth, it was nominally for the harbour of Alexandria to pick up a cargo of currants. The Spaniards grew suspicious, and, interpreting the move as a mission to rescue or avenge John Oxenham, took every precaution that suggested itself in the Isthmus of Panama.

Drake's voyage to the South Pacific was without incident until the Cape Verde Islands were reached. But here joy and sorrow came hand in hand. In the first place Drake captured a Portuguese pilot, Nuño da Silva, whose knowledge of the coasts of South America, and willingness to accompany the English expedition, justified something like real confidence in eventual success. But in the second place, Thomas Doughty, whom Drake had treated as a brother, suddenly threw off disguise and revealed the cloven hoof. No one has been able to discover with exactness what motives were at work in Doughty's breast. It is difficult to believe that he was in Spanish pay, though treachery of that kind was not unknown even in the highest circles. It is more likely that the ambitious youngster had been won over by the advocates of peace, who feared that the maritime schemes of Drake would lead to a definite rupture with Spain. Whatever his motives, there is no doubt at all that, from the Cape Verdes onwards, Doughty did his utmost to frustrate the ends of the voyage. Drake treated him at first with the tenderness he would have shown to a naughty child; but when delinquencies were multiplied, he grew stern and severe, and on one occasion had Doughty bound to the mast. It was not, however, until the mischief wrought by this propagandist had spread from one ship to another, infecting with its poison the whole confraternity, that Drake felt compelled to end his golden project or the life of the man he had loved.

He was not long in deciding. Anchoring his ships in St. Julian's Bay on the coast of Patagonia, he brought Doughty to trial before a court composed of his brother-officers. The prisoner was accused of plotting to frustrate the objects of the voyage; and upon an overwhelming show of evidence was found guilty. Drake then assembled every man who served under him; and, after explaining the case in full assembly, passed sentence of immediate death. Froude has given currency to a tale that Drake himself acted as executioner[1]; but the story is traceable to a tainted Spanish source, and there is sufficient evidence in the English documents to prove the contrary. But that Doughty was decapitated, and died at Drake's bidding, are facts beyond all dispute.

And the question that immediately arises is this: By what authority did Drake sentence to death the most influential personage of all who sailed with him? If it could be established by incontrovertible proofs that Drake had been given no delegated power, then we should have to admit that the charge of judicial murder had not unjustly been laid at his door. But what proof has ever been adduced except the wrangling recriminations of excited partisans? Modern experts have based their opinions on admittedly indirect evidence; and this should be carefully borne in mind when their pronouncements are examined.

Sir Julian Corbett, in his comprehensive work on this period,[2] writing in 1898, says: "It is almost certain that Drake had no express authority to inflict capital punishment." Sir John Laughton goes further. In his Life of Drake in the *Dictionary of National Biography*, after showing how the audacious raider of Darien was introduced by Sir Christopher Hatton into the presence of Elizabeth and was permitted to recount some of his experiences, he continues: "It is probable enough that she received him graciously. His adventures, his daring, his success, were so many passports to her favour, and there is no reason to doubt that, in ambiguous and courtly phrases, she encouraged him to further enterprise; but it is in the highest degree unlikely that, before a stranger to her court, she laid aside her dissimulation and gave a formal commission for reprisals to a man whose repute was that of an unscrupulous adventurer. Such a commission could not have been kept secret, and would have been considered by Spain as tantamount to a declaration of war. Still less can we accept the story that, knowing, as she certainly did know, that he was proposing a voyage which must bring him into conflict with the Spaniards, she said to him, 'I account that he who striketh thee, Drake, striketh me.' Any such speech, if possible—and it is not Elizabethan in its sound—could only have been uttered at a much later period, and most probably in reference to private rather than to public enemies."

There are in this expression of opinion points which detract from its value. We know now that sixteenth-century Governments were accustomed to witness the depredations of licensed corsairs without allowing themselves to be drawn into open warfare. We do not know whether such a roving commission could or could not have been kept secret. The reported speech may or may not carry an Elizabethan sound, but it comes from the authentic narrative of Master Francis Fletcher, chaplain on board the *Golden Hind*.[3] Furthermore, it is logically inadmissible to refer to Drake as an "unscrupulous adventurer," when he is standing his trial in a land where men are held innocent until they are proved guilty. Yet Sir John Laughton is not the most prejudiced of Drake's prosecutors. Those who desire to read a more thorough-paced indictment should turn to Mr. David Hannay's denunciation in the pages of *Ships and Men*.

It must be confessed that among books published before the outbreak of the recent war there is little to comfort those who, studying the life of Drake as a whole, and finding it morally wholesome, have refused to believe that grapes grow on thorns, or figs on thistles. Happily, however, since the summer of 1914, some vital discoveries have been made public which set the whole question in an entirely new light.

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[1] *History of England*, vol. xi, p. 127.

[2] *Drake and the Tudor Navy*, vol. i, p. 235 note.

[3] "We do account that he which striketh at thee, Drake, striketh at us": *The World Encompassed by Sir Francis Drake*. This work, first published in 1626, is based on Fletcher's original notes, which are in the British Museum, Sloane MSS., No. 61.

The first of these we owe to Mrs. Zelia Nuttall, a student of Mexican archæology almost as well known on this side of the Atlantic as on the other. She was, she tells us, some years ago making researches in the National Archives of Mexico, and examining Inquisition trials for Aztec practices, when chance led her to a dust-covered volume lying on the floor. She carried it to a window to see what it was, and, turning over its leaves, came across the "Declaration by Nuño da Silva as to how he was taken prisoner by English pirates on his way from Oporto to Brazil, May 23, 1579." An anxious and excited scrutiny soon revealed the name of "Francisco Drac"; and, under the compelling charm which that name has ever exercised, Mrs. Nuttall tossed aside her Aztec pursuits, and followed up a clue which led her in turn to New York, Simancas, Seville, Madrid, Rome, London, and Oxford.

The first revelation that closely concerns us was contributed by the archives of Seville. But before examining it, we shall do well to take the circumnavigator over another reach of his voyage.

After the execution of Doughty, Drake pushed on; and, with forces meekly submissive to his leadership, and unanimous in their respect to his authority, entered the Strait of Magellan. In seventeen days the passage perilous was passed, and the little fleet entered the Pacific. There they experienced the most terrible weather, and through this the *Golden Hind* alone emerged with limbs unbroken and resolution unshattered. The *Marygold* was devoured by the wolfish waves; and the *Elizabeth* returned through the Strait to England. Drake, with a brain of ice and a heart of fire, explored the seas that threatened to engulf him, and discovered the rolling expanse of oceans to the south of Tierra del Fuego. This momentous discovery supplied him with a homeward route alternative to Magellan's Strait, and, with spirit reinforced by joy and gladness, he ran northward into Spanish domains. At Valparaiso, Arica, and Tarapaca, he ballasted his ship with golden ingots; and on February 13, 1579, with delightful insouciance dropped anchor amongst the native craft in the harbour of Lima. He was almost immediately detected as an alien corsair, and the hue and cry was raised. The Viceroy of Peru mustered every citizen that could fight, and ordered ships to be prepared for their embarkation. The word "Inglese" was passed from mouth to mouth, and then the blood-curdling hiss, "El Draque!"

But the Viceroy was uncertain who the intruder could be, or where his vessel could hail from. He therefore gave orders to Juan Gutierrez de Ulloa (Chief Clerk of the Holy Office) to examine (with the usual rites) three Englishmen still imprisoned at Lima in the cells of the Inquisition. These were no other than John Oxenham, his pilot, and his master; and their depositions, dated February 20, 1579, constitute the fortunate find that Mrs. Nuttall has made in the archives of the Indies at Seville.[1]

Oxenham's testimony (when translated) runs as follows:

"Questioned whether, while in England or since he had left there, he had heard or understood that Queen Elizabeth or any other person had entertained the project to arm a certain number of vessels for the purpose of establishing settlements, or for other purposes, on the coast of the 'North Sea,' or in the region of the Strait of Magellan, or on the coast of the 'South Sea,' he answered that four years ago an English knight named Richard Grenville, who lives at a distance of a league and a half from Plymouth, and is very rich, applied to the Queen for a licence to come to the Strait of Magellan and to pass to the 'South Sea,' in order to search for land or some islands where to found settlements, because in England there are many inhabitants and but little land. The Queen gave him the licence and witness saw it. It was very large (*muy grande*). The said Grenville bought two ships, and was about to buy two or three more, when the Queen revoked the licence because she had learnt that beyond the Strait of Magellan there were settlements made by Spaniards, who might do them harm. The said Grenville sold the ships after the licence had been taken from him. Previously to that, he had spoken many times with witness, trying to persuade him to accompany him, but witness did not wish to do so. Grenville's project was to come and found a settlement on the River Plate, and then pass the Strait and establish settlements wherever a good country for such could be found.

"Witness thinks that if the Queen were to give a licence to Captain Francis Drake, he would certainly come and pass through the Strait, because he is a very good mariner and pilot, and there is no better one than he in England who could accomplish this. Witness thinks that the Queen will not, as long as she lives, grant the licence, but that after the Queen's death, there will certainly be someone who will come to the Strait. The said Captain Francis had often spoken to witness saying that, if the Queen would grant him the licence, he would pass through the Strait of Magellan and found settlements over here in some good country."

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[1] *Archivo General de Indias*, E1, C1, L4·1, No. 32.

Thomas Butler, the pilot, gave evidence which need not be quoted in full. It confirms in the most striking way all Oxenham's chief points. Witness reasserted the Queen's unwillingness to plant colonies where the Spaniards had already founded settlements; but saw in this no reason for the abandonment of Grenville's scheme, only a cause for modifying the projected itinerary. He restated his emphatic belief that no Englishman would dare to pass the Straits of Magellan without the Queen's express permission; and added that Grenville had been obliged to abandon his enterprise because Elizabeth demanded a deposit of £40,000 as guarantee that he would not interfere with Philip's oversea dominions. In conclusion, he found no reason to believe that Drake would attempt that in which Grenville had failed; for the undertaking required a leader of the highest rank, and the Plymouth seaman was mean and obscure.

The master, whose name the Spaniards wrote down as Xervel or Xerores, had little to add to what the other two had said. He confirmed their testimony, especially in regard to the Queen's grip upon all seafarers and their plans; and, though himself had served with Drake in the Isthmian Raid of 1572, he dismissed contemptuously the idea that a Plymouth seaman would gain the succession to Richard Grenville.

This body of evidence, given by men who had been absent from England since 1575, and who spoke under the shadow of death and without any knowledge that Drake, their own captain, was near them, make three things, I think, abundantly clear, viz.:

(1) That within a short time of Drake's return from his Pisgah-sight on the Darien peak (August 9, 1573), Richard Grenville, the greatest magnate in the West Country, applied to the Crown for permission to penetrate by Magellan's Strait to the Pacific.

(2) That a licence of the most far-reaching kind was granted to him for this purpose: and, after preparations had been made, was revoked.

(3) That Oxenham (the only one of the witnesses who would be of a status to be consulted by principals) had refused to visit the Pacific with Grenville by way of Magellan's Strait; but knew that Drake was anxious to do so if the licence, once revoked, could by any means be reissued.

All this fits in with established facts. We know that Grenville enjoyed great influence at Court, and was foremost in the support of all sea-causes. We know of no trait more characteristic in Elizabeth than the grant of a permit for some audacious scheme, and the cancelling of the same at the very last moment. We know that Oxenham had chosen his own route to the Pacific, which was the path of plunder rather than of enterprise. And we know how fervently Drake cherished in his heart his desire to furrow the Pacific with an English keel.

The most striking fact, however, that emerges is this: that Grenville's lordly seizure of Drake's idea, and prematurely impetuous exploitation of the same, made Elizabeth herself the guardian of Magellan's Strait. Drake might reach the Pacific as Oxenham had reached it, or take it in reverse by the Cape of Good Hope; but if he ventured from the "North" Sea into the "South," he would need a renewal of Grenville's letters patent.

Mrs. Nuttall's researches were published in the summer of 1914, and the process of Drake's rehabilitation, which seemed almost completed by her palæographic skill, halted till the recent war was nearing its end.

On July 25, 1917, Mr. R. Pearse Chope, of the Patent Office, read to the Devonshire Association, then meeting at Barnstaple, a valuable paper which has been printed in their *Transactions* under the title "New Light on Sir Richard Grenville."

Basing his researches upon the evidence of Oxenham and his companions already given, Mr. Chope has unearthed the complete Grenville dossier, including the memorial to the Crown craving the necessary permission; a concurrent petition (as we should have expected) to the Lord High Admiral; a dissertation on the objects and advantages of the expedition; and, last but not least, the original draft of the letters patent that Oxenham described.[1] Mr. Chope has conducted his work with commendable patience and skill, bridging the pitfalls with which previous investigators had trenched the road to truth. The documents which he prints (when taken in the mass) add a new vista to our knowledge of the indomitable Sir Richard. But in the present inquiry the letters patent alone concern us. They are, as the Inquisitors learnt from John Oxenham, *muy grande*, which I take to mean "of the most far-reaching description." They are certainly too voluminous to quote *in extenso*. It must suffice to quote that portion which deals with the Crown's delegation of authority, curtailing somewhat (for clearness' sake) the copious legal verbiage:

"Forasmuch as no good enterprise can be prosperously performed without unity and good agreement of such as take the same in hand, which unity and agreement cannot be performed without authority in the Governors and due obedience in the multitude, know ye that of our special grace, certain knowledge, and mere motion we have given and granted . . . to the said Richard Grenville . . . full power and authority to rule and govern all such persons and every of them as shall be retained or go in the said voyage according to such laws, rules, ordinances as by the said Richard Grenville . . . shall for that purpose be made ; straitly charging all our subjects that shall be retained to go in the said voyage to be obedient unto all the said laws . . . as . . . abovesaid, on pain not only of our high indignation, but also of such pains and executions as by the said laws . . . be limited, and on pain if they shall be found obstinately disobedient, or forsake the said voyage, or flee from the said governance . . . upon their return into any of our dominions to be executed and put to pains of death as open rebels by martial law without mercy, remission, or favour.

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[1] The date of these documents is 1574.

" And of our further special grace . . . we give, grant . . . to our said . . . Richard Grenville full power and authority that it shall be lawful . . . to make and establish laws and ordinances and to limit pains and penalties both pecuniary, corporal, and capital, and of death, or otherwise howsoever, for the governance of such as shall pass in the said voyage ; together with power . . . to rule and govern and make ordinances by discretion as occasion shall fall out, although such ordinances be not before expressly written and declared. And . . . it shall be lawful to the said Richard Grenville . . . all the said laws and ordinances to use, practise, and execute ; and the offenders thereof (according to the said laws and ordinances) to punish and correct : and all the persons of the said company rebelliously or obstinately resisting . . . to punish with death or otherwise to punish with pains of death, or otherwise correct without other judicial proceedings but by the Law Martial according to discretion. And all pains and executions of death so to be done and inflicted shall be accompted and judged lawfully done as by our special will and commandment . . . and by force of our most high and absolute prerogative Royal, and as upon rebels against our Estate, Crown and Dignity. For so it is our will and pleasure."

Here, then, we find Elizabeth granting to the first projector of the Pacific Exploration Scheme absolute powers of life and death over all who sailed with him. And it requires no straining of the evidence to argue that the authority granted to the first projector were granted to the second. The actual letters patent reissued to Drake have not been found ; and the secrecy in which the great voyage was cloaked may continue to balk the most careful search for them. But the testimony of the victims in the dungeons at Lima precludes the idea that what was furnished to Grenville was afterwards denied to Drake.

But what was the document in the archives of Mexico that first attracted Mrs. Nuttall's attention and led the way to her other discoveries ? It was an examination of Drake's Portuguese pilot, Nuño da Silva, as to all that he observed while in company with the English. Many questions were propounded to him, but none more eagerly by the Inquisitors than this, " Did the corsair carry a warrant from his Queen ? "

In his reply Nuño da Silva answered " that Francis Drake and all his men said so, and that in Abra de Islas, where they wintered, when he beheaded the said English gentleman who was named Master Doughty, the said Master Doughty challenged him to show whence and by what power he could behead him, and that then the said Francis Drake assembled all his men without omitting a single one. Placing himself in a more elevated position than the others, he took out some papers, kissed them, raised them to his forehead, and read with a loud voice. After reading them he showed them to the others and all saw and inspected them. After the head had been severed he took it in his hand, showed it, and then cast it away, saying, ' Long live the Queen of England ! ' All present said that those papers were his, and from her, and that it was with her authority that he was executing [Doughty] and making this voyage."

Taken by itself, this piece of evidence is significantly impartial ; taken in conjunction with what has already been adduced, it may almost be called conclusive.

There is further testimony, however, of a negative kind which Drake's detractors generally overlook. John Doughty, brother of Thomas (and melodramatic villain of Mr. Parker's pageant-play), also accompanied Drake round the world, was present at his brother's trial and execution, and returned with a whole skin. He was highly connected, had wealth at his command, and the best legal advice was his for the asking. Is it credible that Drake would have escaped the long arm of the law if there had been no letters patent to protect him ?

When the Queen heard the story of the voyage in full, with her lords and ladies she proceeded to Deptford, where she went on board the *Golden Hind*. There, in the presence of the foreign ambassadors, she conferred on Drake the accolade. She may have had her faults. She sometimes found it difficult to make up her mind ; she sometimes favoured the undeserving. She often treated her nobles like schoolboys ; and swore at her Ministers with the relish of a fishwife. But she never forgot the pride of her race, nor what her throne required ; and neither flattery, adulation, nor all the jewels of the Indies would have coaxed her to tarnish the sword in her hand by conferring knighthood on a murderer.

Is it, then, too much to ask the grand jury of his countrymen to acquit Drake of a charge which should never have been brought forward, and to substitute for the vile caricatures of Bernardino de Mendoza the faithful little cameo from Fuller's *Worthies*: "A very religious man towards God; chaste in his life; just in his dealings; true of his word; and merciful to those that were under him"?

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Our Knowledge of the Moon

By Rev. Hector Macpherson, M.A., F.R.A.S., F.R.S.E.

THE moon is our nearest neighbour in space; in fact, it is our earth's peculiar possession—"a detached continent," to quote Flammarion's picturesque phrase. Yet its physical condition is to a certain extent shrouded in mystery; astronomers are not agreed among themselves as to whether or not changes are taking place on its barren surface. From time to time the pendulum of opinion has swung somewhat violently concerning the physical condition of our satellite. In the early days of telescopic astronomy, extravagant notions were entertained of a lunar world analogous to the terrestrial, with oceans, vegetation, and inhabitants. As time went on, it became evident that the moon was a very different world from the earth. In 1794 Herschel pointed out "that we perceive no large seas in the moon, that its atmosphere (the existence of which has even been doubted by many) is extremely rare and unfit for the purposes of animal life; that its climates, its seasons, and the length of its days totally differ from ours; that without dense clouds (which the moon has not) there can be no rain; perhaps no rivers, no lakes." Nevertheless, he clung to belief in the habitability of the moon, holding that its inhabitants "are fitted to their conditions as well as we on this globe are to ours."

Up to the close of the eighteenth century observations of the moon had been sporadic, and work done had been unsystematic. Consequently, beyond the mapping and naming of the larger surface-features, little progress had been made. The foundation of lunar astronomy—or selenography—as a distinct branch of the science was due to Schröter, of Lilienthal, the contemporary of Herschel, whose long-sustained study marked the commencement of the comparative investigation of the lunar surface. Schröter laboured under the handicap of bad draughtsmanship; and he lacked that faculty of subordinating theory to observation which was so characteristic a feature of his great contemporary. To him the moon was a living world, with volcanoes in active eruption and an appreciable atmosphere. Mädler considered that this preconceived idea impaired the value of his work, inasmuch as he was too desirous of recognising signs of change on the moon. Nevertheless, his observations mark the beginning of that detailed study of the lunar surface which is the necessary preliminary to any tenable theory of the condition of our satellite.

Schröter was followed by Lohrmann, a land-surveyor of Dresden, who turned his attention from the survey of the terrestrial to that of the lunar surface. Lohrmann had published four out of twenty-five sections of a detailed lunar chart, when failing sight compelled him to abandon the project. About the same time, Mädler, then a struggling tutor in Berlin—in co-operation with his wealthy pupil, Beer—commenced his well-known survey of the moon's surface, with the aid of a four-inch refracting telescope. The result of this survey was the famous chart—issued in four parts, 1834–1836—which was succeeded in 1837 by a descriptive volume entitled *Der Mond*, in which the authors recapitulated the sum of human knowledge concerning our satellite.

Beer and Mädler's view of the lunar world—changeless, airless, and lifeless—was much nearer the truth than the "baseless fabrics" of Schröter's visions. At the same time, the publication of the book tended to discourage further investigation. Beer and Mädler were believed to have ascertained all that was worth knowing, and to have established the fact that the moon was destitute of change of any kind.

One or two observers, however, were undismayed by the generally accepted view that the moon was a dead world. Of these the chief was Schmidt, the German director of the Greek National Observatory. Schmidt studied the moon for a much longer period than Mädler; indeed, his great chart, published in 1878, was the outcome of forty years of untiring labour. In 1866 he brought forward strong evidence of change on the moon's surface, in the almost complete efforcement of the small crater, Linné. Lohrmann and

Mädler had observed and delineated the crater under a totally different aspect, as had also Schmidt himself. This observation, confirmed by other astronomers, was followed by the equally startling announcement by Klein, of Cologne, in 1879, of the formation of a new crater.

Nevertheless, the majority of astronomers adhered to Mädler's view. Nasmyth and Carpenter, in their classical work on *The Moon*, expressed "the strong belief that no vestige of its former volcanic activity lingers on the moon—that it assumed its final condition an inconceivable number of ages ago"; while conceding that "minute changes of a non-volcanic character may be proceeding in the moon, arising from the violent alternations of temperature to which the surface is exposed during the lunar day and night." Flammarion, forty years ago, was as a voice crying in the wilderness. Referring to the darkening of the floor of the great walled-plain Plato with the progress of the lunar day, he expressed the view that "the odds are ninety-nine to one that it is not the light which produces the effect, and that it is the solar heat. . . . It is highly probable that this periodical change of tint on the circular plain of Plato, visible every month to any attentive observer, is due to a modification of a vegetable nature, produced by the temperature."

The work of Schmidt was carried forward by a number of painstaking English amateurs, chief among whom was the late Mr. T. G. Elger, of Bedford. In 1895 Elger published his reasoned conclusions in a balanced and cautious way in his volume on *The Moon*. His standpoint represented a reaction from the view of Mädler and from the much more extreme version of that view given in so many textbooks. "The knowledge we possess," he wrote, "even of the larger and more prominent objects, is far too slight to justify us in maintaining that changes which on earth we should use a strong adjective to describe have not taken place in connection with some of them in recent years." Elger himself inclined to belief in change. Referring to the varying tints of some of the level regions, he cautiously remarked: "It has been attempted to account for these phenomena by supposing the existence of some kind of vegetation, but as this involves the presence of an atmosphere, the idea hardly finds favour at the present time, though perhaps the possibility of plant growth in the low-lying districts, where a gaseous medium may prevail, is not altogether so chimerical a notion as to be unworthy of consideration." He stated, however, his strong conviction of the need of further intensive study, maintaining that only by confining attention to selected areas of limited extent, and by studying every visible object under all conditions of illumination, could progress be made. "A complete photographic survey of a few selected regions as a basis for an equally thorough and exhaustive scrutiny by direct observation would, it is believed, lead to a much more satisfactory and hopeful method for intimately furnishing irrefragable testimony as to permanency or change than any that has been undertaken."

Elger died in 1897; three years later his suggestion was put into practice by Professor W. H. Pickering, of Harvard, who since the beginning of the century has had the field of lunar astronomy practically to himself. On August 12, 1892, an occultation of Jupiter was observed by Pickering at Arequipa, in Peru, and the slight flattening of the disc was attributed by him to refraction in a lunar atmosphere of extreme tenuity. His observations of the crater Linné during the next few years confirmed him in the belief that the moon was by no means destitute of change. In 1899 an expedition to Jamaica convinced him of the excellence of its climate for the photographic and visual study of the moon, and in 1900 the Harvard astronomical station was erected at Mandeville, a convenient point in the island. The photographs of the lunar surface taken during the following year formed the basis of the large atlas, containing many plates and descriptive matter, which was published towards the close of 1903 under the title of *The Moon*.

Pickering was not the first to apply photography to the lunar surface. At the Lick Observatory a large altas was commenced, but the project was discontinued. At the Paris Observatory Loewy and Puiseux obtained many beautiful photographs; while Weinek, of Prague, formed an atlas combining many Paris and Lick photographs. But the amassing of large numbers of isolated photographs is in itself insufficient to settle the vexed question of change, or, indeed, to add much to our knowledge of the moon. Pickering was the first investigator to carry out the idea of Elger—photography of a few selected regions as a basis for an exhaustive scrutiny by direct observation. The idea has been justified by the progress of selenography since the beginning of the century. Indeed, there has been developed what Pickering himself calls the "new selenography"—"the selenography which consists not in a mere mapping of cold dead rocks and isolated craters, but in a study of the daily alterations that take place on small selected regions—changes that cannot be explained by shifting shadows or varying librations of the lunar surface."

A close study of these "small selected regions" convinced Pickering as early as 1902 that the conventional view of the moon as an absolutely dead world was untenable. He had concluded ten years earlier that a very thin atmosphere does exist, with a density probably not exceeding one ten-thousandth part of our own; and his later work indicated that his conclusion had been correct. It is obvious that only the heavier gases can be components of such an atmosphere; the lighter gases must have long since escaped into space. Indeed, Pickering declares that "any gas that was not constantly renewed from the moon's interior would have practically disappeared from its surface long ago. Let us now see what gases are at the present time being given off from the earth's interior. We find that there are only two that escape in large quantities—carbonic acid and water-vapour. The former would remain for some time on the moon's surface on account of its weight, and the latter because, on account of the low pressure, the rapid evaporation would cause it immediately to freeze."

These theoretical considerations form the background of Pickering's theory of the lunar surface, where he believes volcanic activity to persist on a small scale, and hoar-frost to be extensively deposited. Those who accepted the evidence of Schmidt, Klein, and others as to changes on the moon usually attributed them to the crumbling of rocks due to the extreme range of temperature. Few believed in the existence even of feebly active volcanoes. Accordingly, when Pickering first saw the small crater at the source of a deep winding cleft known as "Schröter's Valley," he was amazed by its strong resemblance to the crater of a terrestrial volcano in active eruption. Clouds of white vapour, of great density, were seen rising from the bottom of the crater and pouring over its south-eastern wall. Observations at Cambridge, Mass., and at Mandeville, confirmed these early results, and showed that this activity commenced a day or two after lunar sunrise, increased to a maximum, and ceased a few days before sunset. Even the few examples which Pickering cited in 1903 were sufficiently striking to lend strong support to the view that lunar volcanic activity had not altogether ceased.

As water-vapour cannot liquefy on the moon's surface, owing to the low pressure, it must immediately freeze. If so, therefore, one would naturally expect to find evidences of snow or hoar-frost on the lunar surface. This is exactly what Pickering has found. He has ascertained that a considerable number of craterlets are lined with a white substance, which becomes more and more brilliant as the sun shines upon it. The same substance is to be seen on certain mountain peaks. Many of these features have been detected, because Pickering has not confined his studies of lunar formations, as most selenographers have done, to the periods of lunar sunrise and sunset when they are most clearly defined. He holds, indeed, that "the only time when the moon is interesting to one who is really used to its surface is when changes are taking place on it, and these only occur far from the terminator; that is, during the lunar summer-time."

Round the small crater Linné is a halo of bright material, which becomes visible a day or two after sunrise. Pickering made a series of measurements of this halo, but they were strangely discordant. At first, indeed, the results seemed inexplicable until it occurred to him "to compare the diameters of the area in question with the number of hours that it had been exposed in each case to the sun. The whole matter then became clear. When the white spot first became visible, one and a half days after lunar sunrise, it was five miles in diameter. As the sun rose the spot rapidly diminished in size, until one day after the lunar noon it was only two and a half miles in diameter. From then till one and a half days before sunset, when it disappeared, it steadily increased in size, reaching a diameter of four miles. During the lunar night it must have continued to increase, until after sunrise it became, as before, five miles in diameter."

The visibility of snow or hoar-frost on the moon is conditioned by two opposing factors: (1) The snow tends to melt under the direct rays of the sun; and (2) the snow only becomes visible when illuminated by the sunlight. As the sun rises higher in the sky, it shines into crevices on the surface and illuminates white regions previously invisible. A striking instance of increasing visibility is that of the bright streaks or "rays" surrounding certain prominent craters, more particularly the conspicuous formation known as Tycho. These streaks, which are seen only about the period of full moon, were a standing puzzle to the older selenographers. Nasmyth supposed them to be due to cracks in the surface filled by an outflow of white material from the interior of the moon, and in this he was followed by Proctor. Pickering's explanation is much simpler. The snow which gives rise to these "rays" lies in crevices, and cannot become visible until the sun has attained a certain altitude. Less convincing, perhaps, is Pickering's explanation of why snow is deposited in these crevices—by winds blowing in certain directions. That the tenuous atmosphere must have some mode of circulation is manifest, however, from recent investigations in 1917 of the minute craterlets near the formation known as Theophilus. The water-vapour expelled from the crater cone obviously does not freeze as it ascends. There is some form of atmospheric diffusion. "These changing snow areas seem necessarily to involve the existence of low cloud or fog in some form or another, and thin clouds doubtless account for some of the less brilliant areas observed." Confirmatory evidence of the existence of fog was obtained four years ago by the Italian astronomer Maggini at Florence. On October 10, 1916, while observing Plato, he noted that a minute craterlet on the floor became invisible, while a reddish mist extended over a portion of the floor and also over the rampart. After three-quarters of an hour the mist cleared away, and the craterlet again became visible.

The evidence which Pickering has collected of the existence of some form of vegetation on the lunar surface is pretty strong, if not fairly conclusive. The possibility of the presence of vegetation was mentioned as long ago as 1858 by De la Rue, while Flammarion suggested it as the explanation of the darkening of the floor of Plato. However, the majority of astronomers dismissed the idea as absurd. Unperturbed by the prevailing scepticism, Pickering began as early as 1893 to make close investigation of a number of variable spots, which darkened rapidly after sunrise and faded out towards sunset. A considerable number of these spots have been studied by him, and it is difficult to refute his contention that they represent a rudimentary kind of vegetation springing up and withering during the long lunar day, which is more analogous to our terrestrial year than to our day. Regarding the nature of this vegetation we know nothing. Pickering has pointed out, however, that "lunar vegetation would have two distinct advantages over our own. In the first place, since the force of gravity is less upon the moon, the same leaves or fronds or branches would require but one-sixth the effort to lift and support themselves that would be necessary were they transplanted to our earth. Secondly, since there are no high winds upon the moon, if it were any advantage to plant life to lift itself above the surface of the ground, it could do so with safety, instead of clinging close to the rocks, like our own arctic and antarctic flora."

It must be admitted that many astronomers hesitate to accept Pickering's conclusions. In a recent lecture, Professor Aitken, of the Lick Observatory, remarked that "further confirmatory observations are desirable before we accept these changes so demonstrated; and even then we may well hesitate to accept the explanations that have been offered." But we must bear in mind that the critics of Pickering's views have devoted no special attention to the surface of the moon, while Pickering is the one prominent observer who, under favourable atmospheric conditions, has studied the moon intensively for over a quarter of a century. Naturally, therefore, Professor Pickering's conclusions must be admitted to carry a great deal more weight than the objections of his critics, however eminent these may be in other branches of astronomy. Therefore we may say, with some degree of confidence, that the balance of evidence is on the side of the view that changes do take place on the moon; in other words, that the moon is not a dead, but a dying, world.

The Herd Instinct taken Seriously

By T. H. Pear, M.A., B.Sc.

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In 1908 and 1909 there appeared in the *Sociological Review* two essays on the Herd Instinct by Mr. W. Trotter. It is fair to say that, whether the reason lay in the unfashionableness of this journal, or the mental resistiveness of the public in 1908, they produced little visible impression upon any but a small circle of workers. Then came the war, and during it, the middle part—"Speculations upon the Human Mind in 1915"—of the present book.[1] This essay contained a comparison of German with English mentality. To many such an effort seemed foredoomed to failure, "for who," they would ask, "can write an unprejudiced account of his own nation or that of his enemy at such a time?" This question, however, is just the one which Mr. Trotter put to himself, and the manner of his answer; the calm, patient, yet firm way in which he has handled some ugly facts commands our profound respect.

Pointing out that one of the best acid-tests to which any scientific hypothesis may be put is its power to foretell the future, he recorded certain reasoned-out prophecies, knowing that before long events would be forthcoming to confirm or refute them. The reader will be interested in, and perhaps surprised at, the opinion, written in 1915, that even though Germany might represent the conflict to others and to herself as a war of defence, there would not be much fighting on German soil.

The postscript of 1919, which is the new feature of the second edition, is not only a perfect example of the art of consolidating one's gains without at any moment appearing to say, "I told you so"; it is perhaps the most sympathetic description and analysis of the post-war weariness, the reasserted segregation of classes (the directions of whose lines of demarcation have probably changed rather less than certain buoyant writers would have us believe), and the sudden deep drop "from the high constancy of spirit by which, throughout the long pilgrimage of war, so many weary feet have been upborne, so many dry lips refreshed."

It will be interesting to watch for criticisms of this postscript by our professional writers upon political affairs. In the light of Mr. Trotter's account of the mind of the politician one might venture a prophecy: but the reader may be left to formulate his own after he has finished the book.

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[1] *Instincts of the Herd in Peace and War*, by W. Trotter. Second edition, enlarged. (London, Fisher Unwin. 8*s*. 6*d*.)

It is impossible to deal adequately here with the substance of the two latter parts of this book, for, as the Irishman said of his three hours' address when asked to summarise it, " it's all gist." The first two essays, however—" Herd Instinct and its Bearing on the Psychology of Civilised Man," and " Sociological Applications of the Psychology of Herd Instinct "—interest the psychologist (or, rather, ought to interest him, for even psychologists have their insensitive sides) because they have already existed in print, and have therefore been open to criticism for ten years.

It may seem strange to say that those essays were simply a plea that the gregarious instinct in man should be taken seriously. They certainly appeared a little while before Nietzsche became the personal property of our Sunday newspapers, though by this time the " psychology " of crowds was a firmly established journalistic favourite. Books which claimed to deal with sociology were already numerous—why, then, this plea?

Mr. Trotter's opinion, if we gather it rightly from his book, is that when the average observer of human behaviour attempts to describe man's undoubted tendency to live in herds of rapidly increasing size, he does little more than to state the obvious facts and to give examples of them. Now this bodily gregariousness, as we may call man's tendency to huddle into the physical proximity of his fellows, which leads to that blackening of the earth's surface with human figures on the downs of Epsom or the front at Blackpool, is by no means the most important feature of the gregarious tendencies which he displays. This merely physical gregariousness is usually described in the detached way which we might expect from an aeroplane observer, or from a philosophical writer peering down from the even remoter altitudes to which he usually soars and at which, not infrequently, he remains.

But this absentee-account of the behaviour of one's fellow-creatures, however kindly and tolerant it may be—though often it is nothing of the kind—is psychologically a thin and poor thing. We would cheerfully exchange most of it for half a dozen of O. Henry's stories of the Four Million, or for an account of life in North London as seen by Mr. Pett Ridge. And for this reason: these two writers make us realise something which the observers in the more rarefied atmosphere do not—the deeply pathetic, profoundly ridiculous, savagely cruel, and infinitely noble *mental* expressions of gregariousness. For all these things arise not as accidents attributable to mere physical proximity, but as definite biological results. Gregariousness, Mr. Trotter believes, " must have consequences as precise, and a significance as ascertainable, as the secretion of the gastric juice or the refracting apparatus of the eye."

To put this in another way: hitherto the cultured writer, knowing that he is relatively immune to the simple mind's fear of bodily solitude, has implicitly or explicitly congratulated himself on possessing few of the more primitive characteristics of gregariousness. But it often seems to be only another product of this same gregarious instinct which insures our friend against such a fear. His bodily isolation is off-set by the fact that in thought he can choose his own company: that, perhaps, he never feels so sociable as when he is alone. Yet to such a first-class traveller on life's journey, the fear of mental loneliness may some day come with perfectly hideous intensity. The possibility of being ostracised by his " set "; excommunicated by his Church; misunderstood by his nearest and dearest—these may straddle across his path so menacingly that any thought or desire which would conflict with the teachings of his herd is switched off automatically while its faintest incipient glimmerings are still at the back of his mind. Before this striking exhibition of man's gregariousness, the Derby Day crowd, " like flies on a plate," as Herbert Spencer described it, becomes so simple as to be almost uninteresting. The mental serenity and complacency of the most superior of superior persons may have been derived from his herd in a way only slightly more complex than that which brings about the visible beatitude, described by Galton, of the South African ox, romping into the company of his fellows after the briefest separation from them.

It is just here that Mr. Trotter offers to psychology either a new discovery or a challenge. If the former, it is scarcely possible to overrate the significance of his book, not only for psychology, but for history, political science, ethics; in fact for every study which honestly attempts to understand the complexities of social behaviour. On the other hand, if Mr. Trotter's suggestion be a challenge, it is remarkable that his gage has remained on the ground so long. We may proceed more easily upon the path which he has indicated if we take some compass-bearings at its beginning. He begins from two truths in biology and psychology respectively. The first is that gregariousness in animals increases enormously their capabilities of offence and defence, and that any member of the herd, in return for the protection from natural selection which his commune affords him, pays the price of a loss of individuality of behaviour. But he goes farther, and points out that, in human beings, this stereotyping of behaviour is paralleled by a similar process in the realm of thought; that man's political and religious beliefs illustrate the advantages and disadvantages of standardised mass-production even more brilliantly than the most popular motor-car.

The second fact from which he sets out is a psychological one, analysed and established, as he says, with a "quite final delicacy and precision," by Professor William James. James "showed that the impulse of an instinct reveals itself as an axiomatically obvious proposition, as something which is so clearly 'sense' that any idea of discussing its basis is foolish or wicked."

So far Mr. Trotter has not departed in any way from the average psychologist's point of view. But his new path begins here, in that he believes that the herd instinct is not only itself the cause of axiomatically obvious impulses, but may lend to any ideal, impulse, habit, or belief, however recently acquired, this character of immediate obviousness. Such beliefs may be held regarding complex subjects like Home Rule or Guild Socialism, or such apparently simple ones as the propriety of wearing made-up neckties or the correct method of eating asparagus. In these cases the feeling of rightness or wrongness is usually "axiomatically obvious," the phrase "It's not done" and the epithet "outsider" providing further evidence in support of Mr. Trotter's theory.

We are therefore asked to believe that the herd instinct can suffuse, or, if we may use, not too rigidly, an analogy, electrify or magnetise an impulse which itself is clearly not instinctive, and may be a very recent acquirement, having no existential value. This is not the place to discuss the effect which the acceptance of such a belief would have on psychology in general; but there is no doubt that some such explanation is required to explain an obvious but important fact. Most people, ninety-nine times out of a hundred, do or think things which their community calls moral or right, not because of any anticipation of reward or punishment, material or social, of praise or blame, of approval or disapproval, but just because it never enters their heads to behave otherwise. Their reasons for doing the "right" thing, though frequently interesting, are usually rationalisations after the event. This, if the present reviewer has grasped Mr. Trotter correctly, is one of the essential facts upon which the strength of his theory depends.

We have no intention of quarrelling here with Mr. Trotter's selection of the words "herd" and "instinct." It is perhaps unfortunate that most of us usually apply the term "herd" to the community (or the plate, to adopt the Spencerian simile) to which someone else belongs, but there is no cogent reason why in future we should not deny ourselves the pleasure of limiting this word's functions to those of a missile. Concerning the word "instinct," however, much more might be said in a technical article, and it seems likely that Mr. Trotter has been misunderstood because he has used a very ordinary word to stand for an extraordinarily complex set of phenomena. To the present writer it appears that the difference, for example, between Professor McDougall's use of the term "gregarious instinct" and Mr. Trotter's use of "herd instinct" is not unlike the difference between the chemist's and the temperance advocate's respective uses of the word "alcohol." The latter does not mean seriously that the average man is prone to feel an overwhelming temptation to drink a liquid the chemical constitution of which can be simply written as C_2H_6O; what he does mean is that the more companionable liquids against which his energies are directed contain alcohol as their indispensable, but not necessarily as their most characteristic, constituent. It may be that upon analysis Mr. Trotter's "herd instinct" will prove to contain a relatively large number of complex products, like the ingredients which make up the flavour of an old wine. We may surmise that such an analysis would result in the discovery of instincts other than the gregarious instinct, habits, and—to use Mr. A. F. Shand's admirable conception—sentiments and integrations of sentiments. Be that as it may, there is very little doubt that Mr. Trotter, once and for all, has set an example, which most other psychologists would do well to copy, of treating, with the seriousness which they deserve, man's gregarious tendencies, their illimitable possibilities and some of their ghastly actualities.

Until quite recently a serious defect in the majority of writings upon social psychology was their neglect of one of the most important phenomena of civilised mentality: mental or moral conflict. The character of the ordinary imperfect human being is seldom built up by an uninterrupted sequence of orderly superpositions of moral acquirements. More often, especially if the person in question be the possessor of an alert, sensitive, and imaginative mind, this structure bears only too plainly, even in its outward pattern, the marks of conflict, not only with others, but with himself. The recognition of this fact in twentieth-century psychology is largely, perhaps almost entirely, due to those pioneers of psychological medicine Janet and Freud. Mr. Trotter was inoculated with these views at a comparatively early date, and the way in which they have influenced him may be a little startling to any reader who has derived his conceptions of Freud's teachings from casual conversation, from the writings of our younger novelists, or from a recent delightful poem in *Punch*. We might go so far as to say that the very nature and functions of Mr. Punch himself would form a most entrancing problem to a student of society who has fully grasped Mr. Trotter's conception of the strengthening influence exerted by mental gregariousness. He might, for example, begin with an analytical comparison of the political cartoons published before and since the Armistice.

Mr. Trotter, then, in a sense, belongs to those writers who—to borrow the poem's jolly rhythm—"derive their inspiration from the works of Jung and Freud," but the colour of the illumination which he focuses upon the present state of society from these writings is quite refreshingly new. Even his attitude towards the psycho-analysts themselves is original. At times one almost gets the impression that he is shocked by the respectability and conventionality of the Vienna school of thought. We hasten to say that it is as a biologist that he is so distressed. He points out a lacuna in the Freudian social psychology which seems so glaring—after one has read Mr. Trotter—that one is left wondering how it could have been allowed to gape so long. Accepting the psycho-analysts' account of mental conflict and repression, he emphasises that, while vividly describing and attempting to explain the process of repression, they often appear compliantly to have taken for granted the permanence—perhaps even the rightness—of the social barriers which bring it about. And some of those barriers are the jealousy of the older towards the younger generation, the apathy and comfort of the well-fed, the serenity and calm which are often merely another aspect of unimaginative stolidity, the righteous satisfaction which is sometimes difficult to distinguish from Pecksniffery or Junkerism.

So far the psycho-analytic school has cast little direct light upon an important question: How many of these imposing hurdles in life's obstacle-race could be desirably lopped down or even removed? Mr. Trotter reminds us of the cynical complacency with which the middle-aged write of the "storm and stress" of adolescence, as if these are due merely to internal—and therefore, doubtless, beneficial—growing pains, and in no way caused by friction against shackles which need never have been forged. A year or so ago a reviewer put the same thing in another way when he described a book as suggesting to parents a number of ingenious solutions of children's religious difficulties which ought never to have occurred.

Mr. Trotter himself says, "However much one may be impressed by the greatness of the edifice which Freud has built up, and by the soundness of his architecture, one can scarcely fail, on coming into it from the bracing atmosphere of the biological sciences, to be oppressed by the odour of humanity by which it is pervaded. One finds everywhere a tendency to the acceptance of human standards, and even sometimes of human pretensions, which cannot fail to produce a certain uneasiness as to the validity, if not of his doctrines, at any rate of the forms in which they are expounded."

Another conception of this writer which immediately attracts the psychologist's attention is his suggested division of minds into sensitive, and resistive or "normal." His two pictures, singularly incisive, though perhaps outlined with too hard a pencil, describe types known to all of us: the person unusually pervious to the lessons of his own personal experience, even when it contradicts the teaching of his leaders and his elders, and the one with his ears constantly pricked towards the herd, immediately rejecting or questioning the validity of his own personal experience when it conflicts with the beliefs and traditions of his community. Such a mind's "resilience to the depressing influence of facts" has attracted many thinkers before Mr. Trotter, but probably none before him have used Freud's teaching in an attempt to discover the biological process by which such a mind's protective armour grows. As Mr. Trotter's thesis is not only that these resistive minds tend by their very stability to become the backbone of the State, but that the post-war condition of our own country, and that of many others, is largely attributable to their dominance by this type, his book will interest many to whom psychology is little more than a name.

This review has attempted to discuss one only of the many brilliant aspects of this book. The eloquent postscript of 1919 speaks for itself and needs no exposition by others.

Mr. Trotter is a surgeon. Here we see him cutting deep into the tissues of the body politic, wisely declining to administer an anæsthetic, and laying bare society's malformations and pathological adhesions. The professional surgeons of the mind may—they almost certainly will—criticise the manner of his dissection. But, at any rate, they should find it rather difficult to regard him as an unqualified practitioner.

Wireless in Aircraft

By J. Brown, M.B.E., M.C., M.A., B.Sc.

It is not proposed here to deal with any of the technical difficulties associated with wireless signalling from aircraft, nor to give descriptions of the special apparatus required for this purpose, as the understanding of these requires a certain amount of specialised and technical knowledge. It will suffice to outline some of the recent developments which have taken place in aircraft wireless, and show to what use these have been, and are being, put.

Wireless telegraphy, though quite a young branch of electrical science, was well known as a successful means of communication before the recent war: many land and ship stations existed, the value of wireless in naval and military operations and in commerce was fully recognised, and suitable types of apparatus were available for such purposes. With aircraft, however, this was not the case. At the outbreak of war the use of wireless in connection with aircraft had not got beyond the initial experimental stage, and no standard types of apparatus had been adopted. The need for rapid and efficient communication between aircraft and the ground was urgent, and under the stress of war conditions suitable types of apparatus were devised and manufactured. During the years of war these changed very considerably as one improvement followed another, new developments took place, and new conditions and increased functions demanded new types. The development has been one of triumphal progress ; enormous difficulties have been overcome, with the result that to-day there is little or nothing in connection with wireless on land or sea which cannot also be done in the air.

A wireless station, whether on land, on sea, or in the air, requires (*a*) electrical power, (*b*) transmitting and receiving apparatus, (*c*) an aerial, and (*d*) an "earth." It is easy to make provision for all of these on land or on ship, where sources of electrical power are available, where an aerial can be erected on masts, where an "earth" is obtained by contact with the ground or with the sea, and where there is practically no limit to the weight or bulk of the necessary apparatus. In the air, however, conditions are different ; as the space available in aircraft is very limited, and weights have to be reduced to a minimum, no large or heavy power plant or apparatus can be carried. The workmanship achieved in this direction during the war was very fine ; transmitters of considerable range for use chiefly in aeroplanes weighed only from 5 to 10 lb., while electric generators capable of producing 600 volts weighed about 18 lb. The source of power for transmitters varied with the type : in earlier and low-power sets accumulators were used, while later sets usually obtained their power from small wind-driven generators. These were fitted to the aircraft in a position in which they would experience the full rush of air while flying ; this turned the windmill propellor attached to the generator, and gave speeds of from 3,000 to 4,000 revolutions per minute. An alternative method to this was to drive the generator by gearing or belt direct from the main aircraft engine. This latter method was largely used in German aeroplanes, but was not adopted to any large extent in British machines, as the wind-driven generator has many advantages over the other. In aircraft the aerial consists of a long length of wire (from about 100 to 300 feet according to the wave-length to be used) with a lead weight at one end. During flight this is trailed from the machine and forms an efficient aerial. Before landing the wire it wound up on a reel. An aerial of this type is obviously an encumbrance to a fighting machine, and was, in some cases, replaced by a fixed aerial attached permanently to the framework of the aeroplane. The "earth" system is obtained by using the capacity of the engine, bracing wires, and other metal parts in the aircraft.

One of the main duties of aircraft during war, and one in which wireless plays an important part, is that of observation of artillery fire, or what is commonly called "spotting." In this co-operation between aircraft and artillery wireless is indispensable. In the early days of the war co-operation was attempted by indicating targets by dropping smoke balls or firing coloured signals over them. This method was slow and unsatisfactory, as signals could not be seen very far, and the correction of the ranging by a very limited number of signals was not satisfactory. When wireless apparatus became available, great advances were made, and the success of aerial observation was assured. Large numbers of squadrons of aeroplanes were distributed along the whole front to co-operate with artillery. Pilots and observers were trained in the methods of observing and correcting artillery fire, were taught a little wireless telegraphy and Morse Code to enable them to report targets and maintain communication with artillery units while correcting their fire. Machines for this purpose were mostly equipped with small spark transmitters with an average range of about ten miles. The power of these sets was intentionally kept low to enable as large a number of machines as possible to work on a small sector without interfering with, or being interfered by, similar machines working in neighbouring sectors. Each heavy or siege battery was equipped with a small field set capable of maintaining communication with the aircraft. When a target was observed, a battery was called up by wireless and given the position of the target by means of its co-ordinates on a map ruled in squares. In a few minutes fire was opened on the target, and corrections sent in simple code from the aeroplane to the battery. With practice, gunners and aerial observers soon became very skilled and quick in ranging by this method, and most successful artillery work was achieved. When necessary, more than one battery engaged the target, and trained observers were able to correct the fire of several batteries at the same time. Arrangements also existed whereby, on a certain signal being sent by the aeroplane, the concentrated fire of a large number of batteries could be obtained at once on a target of special importance, such as a body of enemy troops, a railway train, collection of transport, or similar "fleeting target." Wireless has proved its value for work of this nature, and will continue to be necessary in warfare as the best means of communication between aircraft and artillery, for with modern long-range guns correct observation of the fall of rounds is only possible from an observer hovering over the target. In future, wireless telegraphy may be replaced by wireless telephony for this purpose; this would allow more intimate communication between the observer and the battery commander. Apart from this there would appear to be no very great advantage in using telephony instead of telegraphy for the purpose.

A second important use to which wireless in aircraft was largely put during the war was in connection with long-range reconnaissance flights and bombing expeditions. In carrying out duties of this nature, aircraft flew many miles beyond the enemy front line, and obtained "intelligence" in the course of a three or more hours' flight which it was often essential to report at once without waiting till the whole flight was completed. For example, movements of enemy troops behind the line, concentrations of transport or rolling stock, lighted enemy aerodromes seen during night-flights, good bombing targets, etc., were matters of strategic importance of which immediate knowledge was necessary if action was to be taken in time; this information was best sent during flight by wireless to certain land stations erected for the purpose at suitable headquarters. The supreme importance of rapid communication in reporting enemy movements and dispositions is more fully realised under moving-battle conditions during a large advance or retreat such as took place in the initial and final stages of the war in France, and also in the final phases of the campaign in Palestine. Aircraft engaged on long-range reconnaissance and bombing duties were first equipped with long-range spark transmitters capable of maintaining efficient communication up to about 50 to 100 miles, or more if necessary. Later, after the development of the Three Electrode Oscillation-Valve,[1] and its adaptation for use in aircraft sets, these spark transmitters were replaced by continuous-wave transmitters giving much longer ranges for less power. These continuous-wave transmitters have many advantages over the older spark types, and are eminently suited in all respects for use in aircraft.

The next development to take place in aircraft wireless was in the use of wireless telephony. To the non-technical reader one may say that wireless telegraphy differs from wireless telephony just as ordinary telegraphy differs from ordinary telephony—in the one a code of dots and dashes is used to transmit the message, while in the other the message is transmitted as in ordinary spoken conversation. Wireless telephony demonstrations had been given between land stations before the war, but wireless speech had never been received in an aeroplane. The whole of this momentous development in aircraft wireless telephony has taken place during the years of war, and has been the result of long and patient industrious research and experiment on the part of a few able pioneers. The difficulties to be surmounted were tremendous. Telephone conversation on the ground is often not all that one could desire, but when this has to be undertaken in an aeroplane rushing through the air at about a hundred miles an hour, and amid the continuous roar of a high-power aeroplane engine so deafening that an observer can only hear his pilot's shouted words when the latter's mouth is close to his ear, one can, to a small extent, appreciate some of the difficulties to be overcome. By the perfection of a transmitter-microphone insensible to loud noises such as those of the engine, yet responsive to the modulations of the human voice, and by the use of high-magnification valve arrangements, satisfactory results were at length obtained, and a standard type of instrument was designed and manufactured which necessitated practically no adjustments in the air. With such sets, pilots and observers no longer required to learn the Morse Code and wireless signal procedure; this alone was a great benefit, and, moreover, considerable time was saved in the transmission of messages. Not only were aircraft able to maintain speech communication between themselves and the ground, but they were able to hold conversation with other aircraft in flight. This was of great value in "formation flying," when a number of aeroplanes fly in a body under the leadership of a commander who, by this means, can give directions and orders to the members of his formation and also maintain communication with the ground. For fighting purposes in the air this has obvious advantages; its value, too, was proved by its use in the squadrons employed in the defence of London, as machines on patrol duty in the air could be easily kept informed of the approach or movement of enemy aeroplanes or airships.

Before dealing with the latest development—namely, aircraft direction-finding wireless—it will be advisable to consider briefly and in the simplest possible terms the main principle involved in directional wireless as applied to aircraft.

If, while an operator at receiving station A (Fig. 1) listens to wireless signals sent with uniform power from a fixed station B, the receiving aerial AC be rotated about A, the strength of the received signals will be found to vary in intensity: the signals heard will be loudest when the receiving aerial lies in the straight line joining AB, as shown in the diagram. Now, orienting the aerial of a wireless station is no small task, and is, in most cases, practically impossible. It is found, however, that signals can be received on a closed loop of wire, and that this can be used in certain cases instead of an ordinary type of aerial. The loop consists of several turns of wire wound usually around the periphery of a large rectangular wooden frame. This is mounted so that it can be rotated conveniently about a vertical axis of symmetry in the plane of the coil.

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[1] This is described fully in recent textbooks on wireless, and also simply in the article on wireless by Lieut.-Col. Crawley in the July issue of DISCOVERY.

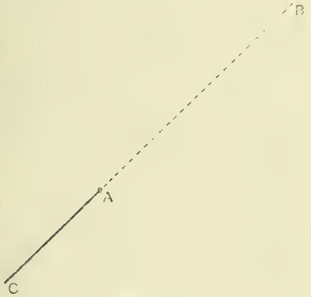

FIG. 1.

Expressed mathematically, the energy absorbed by the coil PQ (Fig. 2) at receiving station R from the transmitting station T is proportional to cos θ, where θ is the angle which the coil makes with the straight line joining the transmitting and receiving stations. This energy will be a maximum when $\theta=0$, i.e. when the plane of the coil lies in the straight line joining the stations. In other words, signals received at R on coil PQ from station T will be loudest when PQ coincides with RT. The application of this principle to direction-finding is easy to see, for suppose the position of T is unknown. An observer at R listening to signals from T rotates the coil PQ until he finds the position in which the signals are loudest. He then knows that the coil PQ points to the unknown station. This is not sufficient to determine the position of T, but if similar observations are made at a second station not in the same straight line as TR, the data are then sufficient to determine the exact position of T. Thus the position of the unknown wireless station X (Fig. 3) can be determined from observations made at two fixed stations Y and Z (Fig. 3). When X transmits, Y and Z, by means of their direction-finding apparatus, read off the magnetic bearing to the unknown station as determined by the position of the rotating coil when signals from X are loudest. The point of intersection of these two bearings gives the position of X. Stations Y and Z are, of course, in communication with each other, either by wireless or by land-line. It may here be remarked incidentally that by such means the position of enemy submarines, ships, headquarters, etc., using wireless during the war were determined.

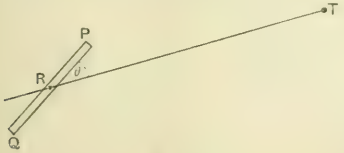

FIG. 2.

With certain modifications and adjustments, the above principle has been successfully applied to aircraft, and at least two main methods are in use. In the first of these the aircraft carries the direction-finding wireless apparatus. To find his position at any time, the aircraft operator selects two land stations whose positions he knows accurately. When these stations transmit, he takes a bearing to each of them by means of his direction-finding apparatus. These two readings (which only take a matter of some seconds) are sufficient to enable him to plot his position accurately on the map. A check can be obtained by taking the bearing to a third station. This method is of great value, especially during war, as the aircraft can determine its position without transmitting and thus revealing its own presence. It also makes flying possible on cloudy nights when landmarks cannot be seen. The stations to which bearings are taken should obviously not be too close together. During peace-time, and also during war-time, there are always sufficient high-power wireless stations (such as Poldhu in Cornwall and Eiffel Tower in Paris) at work to enable these bearings to be taken. Also, for special flights, special transmission, if necessary, can be easily arranged.

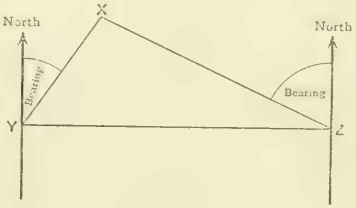

FIG. 3.

For the second method no special direction-finding wireless apparatus is necessary in the aircraft. This is installed in the ground stations, and only an ordinary wireless installation is carried in the aircraft. When its position is required, the aircraft X (in Fig. 3) calls up stations Y and Z and asks for its position. Both Y and Z take bearings to the aircraft by means of their direction-finding apparatus, Z transmits its bearing to Y, where, with the use of both bearings, the position is plotted and then communicated by wireless to the aircraft. The benefit to aircraft of this development in wireless is important, but full use has not yet been made of it. It affords a valuable help in aerial navigation—a science in which only a few aviators are sufficiently skilled. To steer an aeroplane or airship in the dark, or over a large expanse of water or desert where no guiding landmarks are available, or in clouds or fog, perhaps, too, in a wind whose speed and direction are only approximately known, is a task not to be undertaken by any ordinary aviator. Yet on long-distance flights such conditions may be encountered, and accordingly every possible source of help should be made available to the pilot, and not the least valuable of these sources is the use of wireless direction-finding apparatus.

Most of the foregoing developments have arisen from the demands of a war in which science has played a great part, and the high state of perfection attained in all types of aircraft wireless work in so short a time has been largely due to the pressure of war conditions. But such developments do not end with the war. Wireless is as essential to civilian aircraft in peacetime as it is to aircraft during war ; it is as necessary for the safety of an aircraft and its passengers as it is for the safety of an ocean liner and her passengers. Since the Armistice considerable use has already been made of aircraft wireless ; wireless telephony was used with success on the Folkestone-Cologne Aerial Postal Route, and on the London to Paris Air Route (still in use) ; wireless telegraphy and telephony have been largely and successfully used on several long demonstration flights by large aeroplanes, flying boats, and airships. The most important of these was the flight made in July 1919 by the airship " R34," from England to America and back. Her wireless equipment included a continuous-wave transmitter for long-range work, a low-power spark transmitter for communication with ships, direction-finding apparatus, a wireless telephone, and receiving apparatus with valve amplifier. The wireless results were highly satisfactory and some remarkable ranges were obtained. During the whole flight the airship was in wireless communication with stations on this side, or on the other side, of the Atlantic. Weather reports prepared by meteorologists in London were transmitted to her every few hours throughout the flight, and proved of great value. Signals were exchanged with the wireless station at St. John's, Newfoundland, over a distance of more than 1,700 miles. This was the first real test of long-range wireless communication with aircraft, and the results obtained surpassed all expectations. They have demonstrated what can be accomplished, and indicate what may be looked for in the future. If civil aviation is to become the success it deserves to be, one can look forward to the days when the world will be traversed by aerial routes over which aircraft (both heavier and lighter than air) will fly by day and by night, properly equipped with wireless telegraphy and telephony apparatus by means of which communication will be maintained with the ground, receiving weather reports, warnings and instructions when necessary, and guided by night and in cloud by a chain of wireless stations acting as " beacons " for direction-finding.

NOTE.—There are no textbooks on Wireless in Aircraft, but the reader who is interested in the subject may find some assistance in a series of articles, describing standard types of wireless apparatus used in aircraft during the war, which appeared in the *Wireless World* (a monthly magazine published by the Wireless Press, Ltd.), commencing April or May 1919. There are, however, many good textbooks on Wireless Telegraphy and Telephony. The simplest and most useful of these for the ordinary beginner is probably *The Elementary Principles of Wireless Telegraphy*, by R. D. Bangay (Wireless Press) ; in this book a section is devoted to oscillation valves and continuous-wave transmission and reception. Other suitable, though more advanced, textbooks are Rupert Stanley's *Wireless Telegraphy* (Longmans & Co.), Dowsett's *Wireless Telegraphy and Telephony* (Wireless Press), and Erskine-Murray's *Handbook of Wireless Telegraphy* (" The Electrician " Series).

Books of the Month

The following is our monthly selection of books which we commend to the notice of our readers.

FICTION

The Cross-Pull. By H. G. EVARTS. (Hodder & Stoughton, 8*s.* 6*d.*)

Bull-Dog Drummond. By CYRIL MCNEILE. (Hodder & Stoughton, 8*s.* 6*d.*)

Green Apple Harvest. By SHEILA KAYE-SMITH. (Cassell, 8*s.* 6*d.*)

A story of life in Sussex by one who is now in the first class of novelists.

Verena in the Midst. By E. V. LUCAS. (Methuen, 8*s.* 6*d.*)

They Went. By NORMAN DOUGLAS. (Chapman & Hall, 7*s.* 6*d.*)

GENERAL

On the Art of Reading. By SIR ARTHUR QUILLER-COUCH. (Cambridge University Press, 15*s.*)

Collected Poems. By EDWARD THOMAS. Foreword by WALTER DE LA MARE. (Selwyn & Blount, 10*s.* 6*d.*)

The Outline of History. Reader's Edition. By H. G. WELLS. (Cassell, 21*s.*)

This is an edition of Mr. Wells' remarkably fine history less sumptuous as regards illustration than that appearing in fortnightly parts, and consequently much cheaper.

New Studies of a Great Inheritance. By PROF. R. S. CONWAY. (John Murray, 12*s.* 6*d.*)

This book consists of lectures designed to represent some of the elements in the work of ancient writers which make their study of permanent value.

Letters of Mark Twain. (Chatto & Windus, 18*s.*)

This book contains also a biographical sketch and commentary on the letters, by Albert Bigelow Paine.

The Elements of Practical Psycho-Analysis. By DR. PAUL BOUSFIELD. (Kegan Paul, 10*s.* 6*d.*)

An account by a Harley Street man of the theory, technique, and scope of psycho-analysis in a form that may readily be understood by the student

The Advancement of Science, 1920. (John Murray, 6*s.*)

The addresses by the President of the British Association and of the Presidents of the twelve sections delivered at the Cardiff meeting in August.

Potatoes from Seeds

By Miss S. R. Graham

HAVE you ever speculated on the small shiny black balls sometimes seen on potato-haulms after the flowers have fallen? I often have, and wondered why the tiny seeds inside them could not reproduce their species like other seeds, and why potatoes must always be grown from tubers or "sets."

I was never able to obtain any satisfactory reason, and was always put off by the usual statements, "Oh! you can't grow potatoes like that. They only grow from 'sets'"; and when I persisted, and still asked why, no one seemed to know.

At last, however, my childish problem has been solved (in this country) by an enterprising firm of seedsmen, who, after having experimented with these seeds, has put them on the market, in the usual form, and offers prizes to growers obtaining the best results.

The outcome has been most interesting, for dozens of potatoes, of different shapes and sizes and colours, have resulted from the trials already made, and it is hoped that more far-reaching ends may yet be arrived at when more time has elasped in which to study the behaviour of the descendants of these potatoes bred on this new plan.

[*Continued on p.* 312

T. Fisher Unwin's Books

A NATURALIST ON LAKE VICTORIA. With an Account of Sleeping Sickness and the Tse-tse Fly. By G. D. HALE CARPENTER, D.M., B.Ch. (Oxon), Uganda Medical Service. Illustrated, cloth. 28*s.* net.

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Possibly a more hardy disease-resisting root than any yet known to us may evolve. More than that, the experiment may lead on to others, and some horticultural genius more talented than his fellows may hit upon an epoch-making discovery which may affect the food-supply of the whole world.

One such genius has already appeared.

I mean Luther Burbank, the plant wizard of California, whose services to his State and to mankind have been recognised in that neighbourhood by the setting apart of one day a year as a holiday in his honour, and calling it by his name.

I feel sure the English nation would do more than that for anyone who, following in his steps, could by some means increase, say, the yield of the sugar-cane tenfold! Who says this is an impossibility? I am confident that Burbank himself would not admit such a word.

A side-line to this study, less dramatic and striking perhaps, consists in converting what has formerly been an annual crop into a perennial one, with the attendant saving in tillage and seeding, although with naturally greater expenditure on manures. This has been already done in the case of perpetual spinach, and more lately still with broccoli; indeed, I have heard of these new broccoli yielding thirty heads in a season, and doing this continuously for several years; for they are hardy and resist any ordinary frosts.

Perhaps Burbank's greatest achievement of all, and the most valuable to man, is his spineless cactus.

This plant, as we all know, will flourish on waterless wastes where no other vegetation can exist. Also, it was previously known that the stems contained substances rendering them suitable fodder for cattle, but their prickly spines prevented them being of any use in this way, or in fact for anything. But Luther Burbank determined to overcome this difficulty, and trained all his intelligence on the task of creating a cactus without spines, in order that these erstwhile deserts should be no longer barren, but should become grazing lands for herds of beasts, which would find in the new production both food and drink—for the stems contain a large percentage of water.

The history of repeated experiments and disappointments before this end was attained need not be gone into; enough that thousands of acres formerly unprofitable now support large numbers of beasts, which in their turn become food for man; more still, this spineless cactus bears a wholesome and delicious fruit.

Among his other wonders are a white blackberry, a stoneless plum, a dwarf chestnut, and the potato called by his name. All those breed true, and go on doing so. The story of what he has accomplished on these lines on his twenty-two acres in California is a veritable romance. He is himself an enthusiast, as he must needs be, to persevere and keep on trying and trying again in the face of difficulties and set-backs. He has already achieved much, and has a whole-hearted faith in the immense future before this work, and the tremendous possibilities open to those who take it up. His thoughts were first directed to this study by those little potato seeds I mentioned. As a youth, he noticed a seed-cluster on a potato plant, and on sowing these the following year, he was amazed to find that each seed produced a potato absolutely distinct from its brethren. As a result of this experiment, he made sufficient money to take him from his home in Massachusetts to California, where he deemed the magnificent climate would be an important factor in the success of such work. There he has worked ever since, patiently and devotedly; some slight idea of *how* patiently may be formed when we consider that the Sun-berry took twenty-five years to produce a single berry. It was developed from two different *Solanums*, neither of which yielded an edible fruit.

His object in life is to make "two blades of grass grow where one grew before," in which he has been abundantly successful; although he holds that as yet we have only touched the fringe of this vast subject, and sees no reason why this earth could not easily support double the population it now does, if only more people would pursue this fascinating study in a truly scientific spirit.

And what pursuit could be more engrossing or far-reaching in its results? If a discoverer of new continents is a benefactor to mankind, is not he who enriches and beautifies the lands we already know, and enables them to produce two tons of grain, or whatever it may be, where only one grew before? Is not our homage and gratitude due to him in no less degree?

November Number

We hope to print the following articles in the next number:

1. *New Interpretations of Romanticism.* By Prof. J. G. Robertson.
2. *Nelson's Approach at Trafalgar.* By Prof. J. Holland Rose.
3. *The Independence of Psychology.* By Dr. C. S. Myers.
4. *The People of Ancient Rome.* By J. Whatmough.
5. *The Exploration of the Sea.* By Dr. R. N. Rudmose Brown.
6. *Pasteur.* By E. Cahen.
7. *The Potato.* By G. C. Gough.
8. *The Structure of an Atom.* By Dr. A. S. Russell.

The Discoveries in Crete

By George Glasgow, B.A.

(*Continued from August No., p.* 252)

VII

CRETE is the only land of the "prehistoric" Near East which has left no record of itself besides that revealed by excavation. And even the writing on the clay tablets cannot yet be read. We none the less get a vivid impression of Cretan life on its artistic side, and for this the main credit is due to the unique value of pottery in archæology. Pottery is almost indestructible. While it may decompose in soil that is damp enough, and the design may be obliterated when fire plays on it directly and when there is enough air for oxidisation, yet the actual fabric, being made originally of clay baked hard by extreme heat, can never be destroyed by fire. It cannot rust. It cannot be pounded into dust, because a small sherd has a tremendous power of resistance. While the stone ruins at Knossos will one day vanish from exposure to the weather, the pottery will remain. Even the defects of pottery are as valuable to the archæologist as its qualities. Its brittleness led to a constant deposit of breakages. The replacing of breakages in what was a household necessity led to continuous production. Its cheapness made it valueless to looters. When palaces were raided and burnt, metal objects were "lifted" either for their actual value or their potential value in the melting-pot. The pots remained. Thousands of sherds have been found on every site in Crete. Even when fragments cannot be pieced together, they reveal the kind of clay, decoration and thickness of the original vase, and complete examples are often found in tombs, where they were placed as offerings to the dead.

Pottery has been the chief instrument in the formulation of a system of dating. By assuming a lapse of a thousand years for every yard of deposit—except in the Stone Age, when the accumulation of débris was quicker because huts were built of ephemeral material such as mud and wickerwork—each successive layer is relatively dated according to its depth from the surface. Pots provide the nucleus for this scheme because they are found in large numbers in every layer. Other objects take their place according to the type of pots they are found with. The process is not simple. There are complicating factors, and even pottery creates difficulties and irregularities. At Knossos, for instance, when the first palace was built, the top of the hill was levelled and a portion of the former deposit thus cut away. Obviously, too, heirlooms would belong to an earlier time than that of

[*Continued on p.* 314

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the layer in which they are found. Or a pot may be displaced in the earth. A safeguard, however, against mistakes is afforded by the abundance of pots, which makes the differentiation of general classes easy.

Pots, then, are found at the lowest levels, just above virgin soil, for the earliest people used them and broke them. The slowness of development in that long-drawn-out period (the Neolithic or Later Stone Age) is clearly indicated. There are some seven yards of deposit belonging to it at Knossos, and the latest ware shows little or no improvement on the first. The pottery is hand-made, the clay coarse, generally of a sooty-greyish colour and more or less burnished. The relics consist of the rims and handles of pots, rims of basins, bowls, and plates and similar fragments, too incomplete to suggest original shapes. Two interesting points, however, can be seen. The pots were hand-polished both inside and out, and incised lines, or lines simply scratched on the surface, were used as ornamentation. This primitive manifestation of an artistic impulse was later extended by the filling of the incised lines with a white substance for greater effect. Similar ware has been found at Troy and in Egypt, and Dr. Mackenzie[1] has thought that these were an importation from the Ægean.

The irresistible impulse manifested even in primitive people to decorate their ordinary vessels is further illustrated by the fact that the polishing was gradually heightened, and the glitter thrown into relief by ripples, made with a blunt instrument, probably bone, and suggestive of the ripples on the surface of water. Among the latest Neolithic ware found at Knossos are two remarkable specimens of incised ware, the design being that of a twig with leaves. On each side of the stem is a row of small oblong punctuated points, filled in with white chalk. This, it must be remembered, in a period which ended about 3000 B.C.

The Bronze Age, which followed, and which brought with it the Minoan period at Knossos, is remarkable for the first use of paint. The transition was gradual and slow, and indeed, at the beginning of the Bronze Age, there is a falling off in the quality of the pottery. This was due to an interesting result of the discovery of metal, which turned the attention of skilled artists to the new medium, and left the fashioning of stone and clay to inferior hands. On the manufacturing side, however, it is probable that a great step forward was taken at that time. The fact that the clay is now of a terra-cotta or brick colour, as opposed to the former peaty grey of Neolithic times, has led to the surmise that the potter's kiln was now used for baking.

The first paint invented was an almost lustreless black, which was developed gradually into a lustrous black. Even this development was at first used as a mere imitation of the Neolithic black hand-polished vases. The paint was applied all over the vase, inside as well as outside, whenever the neck was wide enough. Neolithic incisions again were imitated by white geometric patterns painted over the black background. This style was not usual till the end of the Early Minoan period (E.M. III).

It was not till the beginning of the Middle Minoan period that any serious development took place. Then, however, it came in leaps and bounds. The potter's wheel had been introduced, probably from Egypt, at the end of E.M. I, and henceforth pots were "thrown" precisely as they are to-day. One can well imagine the keenness with which this great if simple invention was exploited. The fashioning of clay with thumb and fingers on a rotating wheel led so easily and inevitably to fineness of technique that the potter was soon imitating the thinness of metal, and by the end of M.M. II was producing "egg-shell" vases. In design the angular geometric patterns were displaced by the end of the Early Minoan period by curves and spirals, the logical outcome of the use of a brush. Colour meanwhile became lavish and brilliant. There were two styles: either the whole pot was first painted black to provide a background for a light design, or a dark design was painted on the original light-coloured clay. It was the first of these styles that naturally lent itself to colour display, and the name "polychrome" ("many-coloured") has been given to it. The other style (monochrome, or one-coloured) relied for its effect on a simple black-and-white contrast. In the latter case the light natural background was improved by a fine buff clay "slip" or wash. Quite naturally it was the polychrome style that mostly exercised the artists at first. Bright orange, lustreless white, yellow, red, crimson on a black background were exploited to a sometimes fantastic extent as long as the novelty of colour lasted.

The next development took place in the second Middle Minoan period (M.M. II). Relief was then introduced, which created an effect of light and shade on the black varnish. Mere blobs of colour, which constituted the original form of relief, soon developed into raised lumps and horns (the so-called "Barbotine" ware). Middle Minoan "Kamares,"[2] or polychrome pottery, chiefly consisted of cups, "tea-cups," jugs, amphoræ (or two-handled jars), and fruit-stand vases.[3] In the M.M. II period large storage jars, or *pithoi*, made their first appearance. They were as big as a man, and almost exactly like the Cretan storage jars of to-day. Two interesting features in the decoration of these jars are cunningly practical in origin. One was an imitation in relief of the coils of rope which were used in moving the jars, the other a "trickle" ornament produced by allowing splashes of paint to trickle down the side of the jar—a device which virtuously anticipated the inevitable trickles which would result from the storage of oil in it.

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[1] *Journal of Hellenic Studies*, vol. xxiii, p. 159.

[2] So called because the first specimens were found by Professor Myres in a cave on the slope of Mount Ida above the village of Kamares.

[3] The three best specimens are reproduced in colour in the *Journal of Hellenic Studies*, vol. xxiii, plate v.

Towards the end of the Middle Minoan period the exaggerated use of colour which had marked the first introduction of polychrome ware gave way to a concentration upon design. Perhaps the most remarkable specimen of this later phase is the "lily vase" found at Knossos. It stands about two feet high, and for design has a simple row of lilies painted in white on a purple ground. The shape of the vase is artistically made to serve the design by enabling the lilies to bend slightly outward and then to curve in a little at the top.

Then came a curious clash in the separate evolution of polychrome and monochrome ware. The latter had been used as an easy decoration for ordinary vessels, but towards the end of the M.M. period the two styles began to coalesce in the form of a simple light design on a dark ground. Then a final resolution took place by a *volte face* into a monochrome dark on light brought about by the experience that the black varnish was a more durable colour than the lustreless colour pigments. The varnish, indeed, possessed a remarkable tenacity. It probably was the forerunner of that used in the later Attic Black Figure vases, whose secret is still exercising the ingenuity of modern potters. As yet nothing further has been established than that the varnish was not a "glaze" in the modern sense. A contributing factor to the final triumph of the monochrome over polychrome rested upon simple necessity.[1] When naturalist motives became dominant in the painter's art, the lack of a green pigment left no satisfactory alternative to the general abandonment of variation in colour. In L.M. I, when the complete absorption of the polychrome into the monochrome style took place, we find a general use of a brilliantly lustrous brown-to-black "glaze" paint on a buff clay slip, carefully polished by hand on terra-cotta clay. The naturalism of plants and flowers now extends to sea-objects—fish, shells, weeds, rocks—and is marked by careful truth to life. A striking example of this style is the famous "octopus" vase found at Gournia.[1]

As the rise of Cretan civilisation had been faithfully reflected in pottery, so was its fall. One can trace in it the general decadence of Crete. In the eventful L.M. II period, which saw the final destruction of Knossos and the sudden end of Cretan greatness, the

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[1] See Hawes, *loc. cit.*, pp. 126–7.

[*Continued on p.* 316

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pottery becomes stiff and grandiose. Plants and animals are rendered in a spiritless, conventionalised manner. Degeneration was rapid, and in L.M. III (which represented the last stage of Minoan culture) the potter held his brush quite still and let the spinning pot do the rest. There was no decoration beyond an occasional group of horizontal bands, the mere framework of earlier designs.

There were, of course, other forms of pottery besides vases. Cretan potters, even more than those of to-day, used clay as the material for hardware. Not only bricks, drain-pipes, ornaments, but lamps, kettles, even cupboards and tables, were made of clay.

(*To be continued*)

Correspondence

THE METEOROLOGICAL OFFICE AND THE AIR MINISTRY

To the Editor of DISCOVERY

SIR,

Mr. D. W. Horner, in his article on Modern Methods of Weather Forecasting in your September issue, mentions, with some approval, the placing of the Meteorological Office under the Air Ministry. Most independent meteorologists, and if truth were known most official meteorologists also, deplore the fact as little short of disastrous for the best interests of meteorology in this country. Only one side of meteorology appeals to the aviator, and its other sides are not likely to come off well when the finances of the Meteorological Office are controlled by the Air Ministry. The meetings of the Meteorological Committee are presided over by an officer in the Ministry who in general will not have had the scientific training to enable him to appreciate meteorological problems outside his own province. Officials in the Meteorological Office are now civil servants, and are debarred from taking part in any public discussion bearing on the work of the office. Even the *Meteorological Magazine*, which in former times, as *Symons's Meteorological Magazine*, used to publish abstracts of all papers read before the Royal Meteorological Society, cannot now publish such extracts if they criticise the work of the Office. The Office has been quietly taken over by the Air Ministry without any show of reason, and without any committee of inquiry such as there has always been in the past when there has been any change in the status of the Meteorological Office.

C. J. P. CAVE,
Captain late Meteorological Section R.E.

DITCHAM PARK,
PETERSFIELD.
September 7, 1920.

DOWSING

To the Editor of DISCOVERY

SIR,

I was interested in your remarks upon water-divining, or dowsing, as you call it, in the September number of DISCOVERY.

I know very little about dowsing, and certainly I have neither experience nor training in the matter to offer an opinion of any value on the subject, but I am inclined to agree with your view that there is no physical action between the water underground and the twig. How could there be ? But I disagree with you in this : I do not think that dowsing is a problem for the psychical research people at all. It is a matter for the experimental psychologist.

My view is that some part of the dowser's mind knows in some way all the time the whereabouts of the thing sought for, and this carry-on of his with the twig of hazel in his hands is only (unconsciously, of course) a means of getting the subconscious part of his mind to communicate with the conscious.

There are probably lots of other ways of dowsing besides using a hazel-twig, and I believe that *anything at all* can be dowsed if the dowser's subconscious mind is set upon wanting it. Here is a thing that happened which seems to bear out this theory. While I was reading your remarks, it dawned upon me suddenly that there was a thing in my own home which I might with profit attempt to dowse. About three months ago, I lost or mislaid a bunch of keys, and search as I would, high or low, I could not find them. I think I must have sought everywhere for them. So I put down your paper, imagined myself a first-class dowser, and joining my hands, as a timid diver might on a cold day previous to his first plunge, began to dowse. In less than twenty seconds I found myself in a very dark pantry rummaging under an old linen overall. There I found a glass jar which in better days had contained chicken-and-ham paste, now filled with screw nails, and hidden in the nails were my keys. I seemed to get there without any let or hindrance, and certainly those keys were the very ones I had sought for in vain.

Of course, this may be entirely a coincidence. I am inclined to think not.

F. MORETON.

GLENAVY,
CO. ANTRIM,
September 8, 1920.

[This letter deals with an interesting experience. It has, however, nothing to do with dowsing, where the knowledge of the whereabouts of the thing sought cannot be in the mind of the dowser or of anyone with him.

Other letters on this subject have been received, for some of which we regret we have no space. Most of these letters deal exclusively with the marvellous things that dowsers have done and can do. What we really want to get at, however, is an explanation of the phenomena, and an account of experiments undertaken to test any hypothesis put forward.—ED.]

Reviews of Books

O. Henry. A Biography. By PROF. ALPHONSO SMITH. (Hodder & Stoughton, 10s. 6*d.*)

American writers, especially short-story writers, are wonderful people. See them in real life or in evening dress, and they are indistinguishable from dentists, architects, or University lecturers. Talk to them, and if they reply at all they will speak in soft, quiet, and melodious tones, with their straw hats pressed hard against their hearts. Visit them in the offices where they make their stories, and there they are dictating quietly to a prick-me-and-I-shall-bleed young gentleman at a typewriter. Invite them to visit you, and no men were ever so quiet, so polite, so well-behaved. It is only when the lamps of their lives have gone out, and the biographies have appeared, that you realise that unawares you were entertaining angels of a very special kind. You find that the pleasant man whom you imagined living a quiet life, taking a pass degree at Harvard, marrying a clergyman's daughter, and commencing authorship with a volume of poetry, was in reality somebody very different. He shone shoes at seven, dispensed drugs for his grandfather at sixteen, and never went to college at all, or, if he did, paid his way through by farming in the summer. By thirty he had ranched in Texas, cruised in the South Seas, visited Klondike, butted into one or two little wars, and bought land and settled down in Kansas City, Kansas. He could ride, swim, shoot, fish, hunt, and box, so he didn't see why he shouldn't write also. Story writing gave him just the scope for self-expression he required, so he married, took a trip round the world, lived in Boston, removed to 'Frisco, and finally settled down in Brooklyn and wrote. Alas! that at forty-five he died.

I do not wish to imply that the above is to be taken literally as applying to O. Henry, but he was a true member of the restless and adventurous breed that it describes; the men who have had a rich experience of the world, and who possess in addition the essential qualities of a good story-teller or of a good conversationalist—quickness, humour, a power of seeing connections, charm of manner, readiness and sympathy.

O. Henry was a pen-name. The real man was William Sydney Porter, a native of North Carolina, who was born in 1862, and who died in New York City in 1910. In early youth he gave up a post as chemist's assistant for ranching in Texas. After several years of that he did clerical work in various capacities in Texan cities, and in his spare time sent in jokes, poems, and stories of a humorous nature to the papers. The editors put them in and asked for more, indeed complained that he didn't send them enough. This is a complaint that many writers would like to hear more frequently, and it induced O. Henry to give up his clerical work for that of a reporter on the *Houstoun Daily Post* in 1895. The next year a calamity overtook him. He was ordered to go to Austin, the state capital, to stand trial for embezzling the funds of a bank in which some years previously he had been teller. He started off on this journey, but before he reached its end he changed his mind and his train, and

[*Continued on p.* 318

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travelled to New Orleans instead. Viewing this with the wisdom that comes after the event, we see it was a bad mistake. Like Conrad's Lord Jim, he made one fatal mistake at the supreme crisis of his life, a mistake from which he could never recover.

From New Orleans he sailed to Honduras with the intention of settling down somewhere in Central America, but after some months' sojourn in "that land of drowsy caliphs," he returned to Texas owing to the serious illness of his wife. The following year (1898—his wife had died in the meantime) he stood his trial and received a sentence of five years, which, by a process of multiplying by two and dividing by three, was subsequently reduced to three years and a few months. This period (1898–1901) was passed at Columbus, Ohio. This gaoling of O. Henry was a peculiar business. There seems to be no doubt in the minds of those who know the facts that O. Henry was innocent. He said so himself, and always maintained so. One of the charges preferred against him referred to a time when he had left the employment of the bank, but O. Henry, perhaps unwisely, refused to put up any kind of a defence at all.

In the gaol, of course, he got lots of copy. *The Gentle Grafter*, probably the best of his books, was worked up from material gleaned there, and one of his best stories, the story of the reformed burglar who gave away his former occupation by opening a safe to release a little girl who had accidentally shut herself in, was suggested by a story told him by a fellow-prisoner, who, although guilty of many crimes, was actually doing time for something he had never done. Life was made more tolerable also by the kindness of the prison doctor. This man gave O. Henry a job as drug clerk, and later recommended him for a post in which he was more a servant than a prisoner. One of the most enjoyable things in the book under review is the collection of letters that O. Henry wrote from prison to his motherless daughter. They were lively, humorous, affectionate, and care-free epistles, and there was no word in them which would lead his daughter to suspect that her separation from her father was due to his being in gaol.

In prison O. Henry commenced writing the short stories that were afterwards to bring him fame. In his previous journalistic work he had written under his real name, but a desire to break with the past on his release led him to adopt his *nom de guerre*. To conceal himself further he posted his contributions to a friend in New Orleans, who reposted them to the editors in New York. Most of his stories were accepted and paid for, and their publication attracted notice at once. On being released in 1901 he went to New York, and there began the great creative period of his life. He became a recluse. His New York friends did not know his past history. His friends in North Carolina and New Orleans did not identify the Will Porter of their experience with the O. Henry of New York, variously styled the American Kipling, the Y.M.C.A. Boccaccio, the Homer of the Tenderloin, and the twentieth-century Haroun Al-Raschid, until photographs appearing in the literary papers gave him away.

O. Henry wrote short stories only. At first these dealt with his experiences in Texas, the West, and Central America. Later, New York—the little village on Father Knickerbocker's farm with the shady lane running down the centre—became his principal theme. Of 115 stories written in 1904 and 1905, all but sixteen deal directly or indirectly with New York City. With one paper he had a contract for a story each week, and for this he received £20. Professor Smith thinks that were he writing now O. Henry would get about £200 a story. Whatever sum he might have received, his bank balance would not have been great. He did not believe in treasuring up the things of this world. Money passed through his hands like water through a sieve. He initiated a system of giving tips to waiters which were twice as large as the bill itself. Frequently he got down to his last dollar, but this he was always ready to share. He gave away to the poor clothes that he needed himself, and, like a real Christian, even asked the beggars to call again.

Professor Smith says that if ever the man and the place met, it was when O. Henry strolled for the first time along the streets of New York. In a letter to his (second) wife O. Henry writes: "I could look at these mountains a hundred years and never get an idea, but just one block down town and I catch a sentence, see something in a face—and I've got my story." New York, and the people in it, and all about them, were the things he loved and the things he could describe best. *The Voice of the City* and *The Four Million*, which deal with New York, contain the finest short stories since the days of Hawthorne and Bret Harte.

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He died as he had lived, happy, easy-going, optimistic, with the catchwords of the street and the refrain of a music-hall song on his lips. "Turn up the lights," he said. "I don't want to go home in the dark."

A. S. R.

OTHER BOOKS RECEIVED

The Psychology of Dreams. By DR. WM. S. WELCH. (Kegan Paul, 12*s.* 6*d.*)

The History of Social Development. By DR. F. MULLER-LYER. Translated by E. C. and H. A. LAKE. (George Allen & Unwin, 18*s.* net.)

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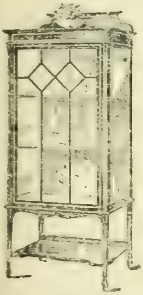

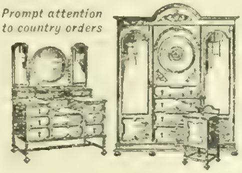

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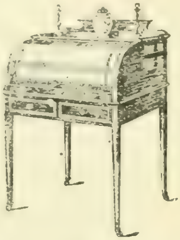

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Editorial Notes

IT is a curious thing that the conventional idea of an archæologist or an antiquary should be exclusively that of a dear old boy with broad-rimmed spectacles and a snuffy waistcoat. Why this should be so is a difficult matter to decide. Some day, doubtless, calculations will be made, at the instance of novel-readers, to estimate the actual percentage of Scots who, in real life, have red hair and projecting teeth, and who refer to Sunday as "the Sawbath," or of Welshmen who habitually say "Look you," or of clergymen who behave like the curate in *The Private Secretary* (or is it *Charley's Aunt*?), and so on, so that suitable action may be taken against the novelists who persist in generating these types. Doubtless a calculation of the percentage of "tame archæologists" among real ones will be included in this investigation, and it will be interesting to see, when the results appear, what this percentage will turn out to be. Very small, we feel sure.

* * * * *

Some adventures of real archæologists[1] in their work of excavation are described in this simple, cheerful, and absorbingly interesting book of Mr. Woolley's. It deals with dead towns and with men excavating in them who were very much alive. Hamoudi, the native head-foreman of Mr. Woolley's expedition at Carchemish, on the Euphrates, was one of these. His temperament might be conservatively set down as reckless, and there was a measure of high spirits about him which among dull and conventional people might even be classed as originality. One of Hamoudi's prerogatives was to celebrate any discovery made in the digging by firing a revolver, the greater the discovery, the more the number of shots (up to a limit of eight) fired. The discovery of a fragment of sculpture evoked the emission of one round from the barrel; something bigger, perhaps three or four; while something really important like a slab with figures and inscriptions led him to blaze away the maximum number of rounds. The Arab workmen, of course, being sportsmen, entered fully into the spirit of this excellent game, doing all they could to ensure the maximum expenditure of fire by the finds they made, and this system of celebration by results, although depressing to a conscientious excavator who happened to find nothing, worked harmoniously on the whole, and much to the satisfaction of Mr. Woolley and his colleague, who, being Englishmen and sportsmen, not only provided the cartridges for the occasion, but gave also money-prizes to those who found the chief relics.

* * * * *

An archæologist who goes out to excavate a site, as Mr. Woolley tells us, "gets to know countries and the ways of men from a point of view other than that of the tourist or of the resident official. . . . He is thrown into close touch with just that class—the labourer and the country villager—which is least obvious to most; he penetrates into the less known parts, becoming more familiar with some obscure town or lonely hamlet than with the social centres that attract the casual visitor: he speaks the language of the people, and, because of duties toward them freely shouldered, becomes in a measure a sharer of their life and of their confidence." An archæologist must be able to organise, to manage men. He must be self-reliant, for his job is an out-of-doors one, a practical one in a foreign land. And in addition he must know something of the technicalities of the job he is on, the history of the country he is in, the language spoken in it by the men who do the digging for him; and, like the explorer, the more he knows of photography, surveying, chemistry, engineering, botany, accounting, and medicine, the better. So if he is to succeed at all, in addition to being a real scholar, he must combine many of the best qualities of the soldier and the diplomatist. Away, then, goes our old boy with the dank hair, the offshore stoop, and the snuffy waistcoat, with a spade on his bent shoulders and his eyes upon the ground!

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[1] *Dead Towns and Living Men: being pages from an Antiquary's Notebook.* With 24 illustrations. By C. Leonard Woolley. (Oxford University Press, 12*s*. 6*d*.)

* * * * *

Mr. Woolley's book deals chiefly with the lighter side of his work as an archæologist, first with Dr. MacIver in Southern Nubia (Mr. Woolley thinks archæologists should always commence in Egypt), then at Teano, between Naples and Rome, and later, during the years just before the war, with Mr. T. E. Lawrence at Carchemish, the ancient capital of the Hittite Empire, on the Euphrates. It is in the main a straightforward personal account of his experiences, containing anecdotes and sketches of individuals which are of quite absorbing interest, not merely because they deal with happenings and individuals of an uncommon type, but because of the plain and unaffected way in which they are told. Most of the book deals with the work at Carchemish, for it was there the author spent most of his time. This town (mentioned in Isaiah), near Jerablus in Northern Syria, has long been a fortress in a troubled land. About four thousand years ago it was the capital of the Hittite Empire, and since then has been successively a seat of Assyrian, Greek, Roman, Byzantine, Armenian, and Arab civilisations. It is accordingly a fruitful, if somewhat complicated, site in which excavation can be carried on.

* * * * *

Mr. Woolley found the Arab workmen who did the digging for him great fellows. They were sportsmen with a keen sense of humour, and most zealous and honest excavators. Some of the more original of them are described. Hamoudi, who celebrated the finds, has already been mentioned. Haj Wahid was another. He was employed as general factotum, and at table was a model of gentlemanly deportment, which behaviour altogether belied his past. At Aleppo, his native town, he had had the distressing habit, when drunk, of amusing himself by hiding on a flat house-roof and holding up all the traffic at the city gate with rifle and revolver. On another occasion, as a consequence of a flirtation between himself and a Mohammedan maiden, he was set upon by four of her brethren and two of her kinsfolk. A Homeric conflict took place. Four of the assailants lay dead on the ground, one was badly wounded, and the sixth fled for his life. Haj Wahid, the sole representative of the other side, was made unconscious, being badly wounded all over, but especially in the head; but a man of his vitality quickly recovered, and as *four* murders in one night could not be overlooked, he received three years' imprisonment, at the end of which he found congenial change in the service of Mr. Woolley.

* * * * *

The reader may obtain a very good idea of the difficulties an archæologist may have to deal with from an account of an interview between Mr. Woolley and the Turkish authority at Birijik, the headquarters of the sub-province within which lies the site of Carchemish. Mr. Woolley had engaged a gang of workmen to commence excavation at Jerablus, when orders came from the Turkish authorities that, as he had no official permit, he must not touch a stone. The time is the year 1912.

* * * * *

"I introduced myself politely, and after thanking him again for the care taken of our site, explained that there had been a misunderstanding about our identity, and asked him to issue orders to his soldiers for the work to start. He answered bluntly that he would give no orders of the kind, as we had no right to the place.

"'Oh yes, but I have,' said I; 'here is the *firman* from Constantinople granting permission'; and I handed it to him.

"He looked at it for some time, then said, 'Precisely, this is all in order, but it is made out in the name of Mr. Hogarth, whom I know, whereas your name, you tell me, is Woolley.'

"Now this was the weak point in my armour, for although the authorities at Constantinople had been officially informed that I was to take Hogarth's place, and had raised no objection, yet the Turkish law distinctly states that permits for excavation are non-transferable, and no written correction had been made on the papers in my possession. So I determined to avoid the issue, and agreeing that the permit was made out in Hogarth's name, I pointed out that I was acting as his *wakil*, or representative.

"'And how can you prove that?' demanded the Kaimmakam [Governor], pressing on the false scent.

"'Easily,' said I; 'here is a letter from Mr. Hogarth authorising me to act in his name, and here is an official communication from the British Museum, which, as you probably know, is a Department of the British

Government, directing me to take Mr. Hogarth's place at Jerablus,' and I handed him these two documents also.

"He looked at them; then, 'What language are these in?' he asked.

"'English,' said I.

"'Ah,' he replied, 'I do not understand English.'

"'Well, that is simple enough,' I retorted. 'You have a French-speaking interpreter here; call him in and I will translate the documents into French, and he can put them into Turkish.'

"'I should not trust such a translation,' said the Kaimmakam; 'and until the British Museum issues this order in Turkish I shall pay no attention to it.'

* * * * *

"In vain I pointed out that this was absurd; the Governor refused to listen to reason in any form, and matters seemed to have reached a deadlock. So I shifted the ground again, and abandoned argument for insistence. I told him that I had been sent to do a certain piece of work, that my papers were in order, and that I could not agree to any delay; I had already engaged my workmen, and I wished to start operations the following morning.

"'It is impossible,' said the Kaimmakam, and ostentatiously turned over some papers on his desk to show that the interview was at an end.

"'But I *shall* start to-morrow,' I urged.

"'I have forbidden it,' said the Kaimmakam, 'and I shall give further orders to the soldiers to stop you.'

"'You have only ten men at Jerablus,' I replied, 'and I have a hundred and twenty who want to work; I shall start to-morrow.'

"'If necessary I shall send more from here,' he retorted, 'but it will not be necessary.'

"I was getting annoyed by now. 'If you send all you've got,' I told him, 'I shall still outnumber you, and my men are just as well armed. I only hope that you will come at the head of your soldiers, and I shall have great pleasure in shooting you first; for I shall certainly start to-morrow.'

"'This is nonsense,' said he. 'You would not dare to shoot at the soldiers; and you shall *not* do any work.'

* * * * *

"The position was a difficult one. I felt that the whole future of our diggings depended upon this interview, and that it was worth risking a lot to get success. If I gave in now, a fresh permit would certainly not be forthcoming that season, and we should have lost all caste with the natives; really, to use force was, of course, out of the question—but would a Turk be sure of that? I looked once more at the Kaimmakam, who, with a cold shoulder turned towards us, was again fidgeting with his papers, and I made up my mind that he was not a man who would call a bluff. Taking my revolver out of its holster, I got up and, walking to the side of his chair, put the muzzle against his left ear. 'On the contrary,' I said, 'I shall shoot you here and now unless you give me permission to start work to-morrow.' The Turk absolutely collapsed. He leant back in his chair, his hands flat on the desk before him, and tried to turn his head towards me, while his lips twisted into a wintry smile. 'Certainly,' he said. 'I see no reason why you should not start to-morrow.'

"'Will you write the order to the *onbashi*?'

"'But with the greatest pleasure; and I will send it down by a special messenger to-night.'

"'No, you won't,' I said. 'You'll write it here and now, and I'll take it down myself.'

"The revolver was still touching his head, and he felt it was useless to try any further trick, so pulling a piece of paper towards him, he wrote something in Turkish and handed it to me. 'That is what you want,' said he. 'Perhaps,' I replied, 'but I am not certain of the translation. Please send for the interpreter, who will put it into French for me.' I sat down then, still keeping the gun handy, and the interpreter duly came and the order was found to be correct. The Kaimmakam's manner had completely changed. He pressed cigarettes on us, sent for coffee, and was full of amiable small-talk, but we soon tired of his forced civility, and cut short our visit on the plea of the long cross-country ride before us. Indeed, it was dark before our weary steeds drew near to the Kala'at, and we saw the glimmering outlines of the lighted tents surrounded by a crowd of anxious workmen. Then Haj Wahid spurred his horse on ahead, and long before he reached the camp, crack! crack! his revolver firing in the air announced the news of our success. In a moment there was pandemonium: a hundred men were blazing away all the cartridges they had, and we rode in through a lane of dancing Arabs, shouting and shooting in honour of the victory, which Haj Wahid's trumpet voice was declaiming with more than Oriental imagery. It was a good beginning for our work, but if I went to bed that night tired out, it was less by my fifty miles' ride than by the strain of the few minutes in which I had staked so much on a guess."

* * * * *

We are sorry that reviews of several important books, and also one of the articles promised last month, have had to be held over to the next issue owing to lack of space. In *Books of the Month* in the October number a book by Professor Conway was in error referred to as published. The price mentioned there is considerably higher than the price at which it will be sold when it appears.

The Exploration of the Sea

By R. N. Rudmose Brown, D.Sc.

It is little short of fifty years since H.M.S. *Challenger* sailed on her world-circling cruise of three and a half years' duration. The expedition, as is well known, was dispatched in 1872 by the British Government for the physical and biological examination of the ocean basins, and was under the command of Captain (later Sir George) Nares and the leadership of Professor Sir Wyville Thomson. The results of that expedition, published by the British Government in fifty large volumes, inseparably associated with the name of their editor, Sir John Murray, laid the foundations of the science of oceanography. Previous to the cruise of the *Challenger* there had been some deep sea investigation, especially in the North Atlantic and Arctic Seas, but most of the great oceans had never been explored, and very little was known of the physics and biology of the sea. The work of the *Challenger* was followed up by many expeditions, but few under British auspices. American, Dutch, and German vessels have investigated the Pacific Ocean, while a number of nations have taken part in the exploration of the North Atlantic, but British enterprise has not been conspicuously in the forefront. Oceanographical research is a relatively costly and difficult undertaking. These considerations delayed its development. Practically all research has to be done by indirect methods whose accuracy depends on the delicacy of the instruments and the skill with which they are handled. The observer is at one end of a wire and his instruments are at the other, separated from him by a distance possibly of several miles. To add to the difficulties, the work has to be done on a vessel which is rarely steady, and not infrequently is in violent motion.

The equipment of an oceanographical expedition on a large scale is beyond the scope of individuals or learned societies, with their scanty resources, in these days. State help is essential if the work is to be undertaken on an adequate scale worthy of a seafaring nation. Since the days of the *Challenger*, great improvements have been effected in the apparatus used for this kind of work, and new vistas of research have opened. Probably the greatest improvement in apparatus is due to the substitution of wire for hemp ropes in all apparatus. The *Challenger* sounded with hemp lines ¼" in diameter, while in modern sounding, piano wire 1 mm. in diameter is employed. The finer wire not only curtails a great saving in space on board ship, but also meets with far less friction in the water, and so enables soundings to be taken with greater speed and accuracy. Great improvements have also been effected in the sounding machine itself, the sounding tube and methods of releasing the weights. For the problems arising out of water temperature and analysis, much new apparatus has been devised since the days of the *Challenger*, a great deal of it through the devotion of the Prince of Monaco to oceanographical research. Swedish and Norwegian oceanographers have also done much in this direction. Reversing thermometers worked by a sliding weight down the wire or by propeller release have now taken the place of maximum and minimum thermometers. Appliances for collecting marine life at all depths have been much improved. Here, again, the hemp has given way to steel in the ropes employed. This gives greater strength, ensures speed in working, and saves much space. The trawl, the dredge, and the townet have all been made more efficient. It is now possible to collect organisms from all depths of the oceans and bring them to the surface in good condition. Much attention has been paid in recent years to apparatus for catching plankton, and many useful nets have been devised.

The work of the *Challenger* stands, but it requires amplification by modern methods. In its day it was pioneer work, and in many seas there has been little or no oceanographical work since the days of the *Challenger*. New problems have also arisen and require investigation. The North Atlantic Ocean, the southern part of the Greenland Sea, the North Sea, and the Mediterranean have been fairly well, but not exhaustively, explored. The coastal waters of many parts of North America and several other parts of the world have been carefully examined. But vast tracts in the Pacific, South Atlantic, and Indian Oceans remain to be explored. The Southern or Antarctic Ocean is imperfectly known, although, strangely enough, it has received rather more attention by modern methods than some more accessible waters. This is due to the many Antarctic expeditions in the ten or fifteen years before the war, notably Bruce's expedition in the *Scotia*, Nordenskjöld's in the *Antarctic*, and Mawson's and Davis's in the *Aurora*. Antarctic and Arctic seas would, however, be outside the scope of a general oceanographical expedition, owing to ice conditions in those waters demanding a highly specialised type of ship. Yet a great deal of pioneer work remains to be done outside the limit of floating ice. To give but one instance, the vexed problem of submarine connections between Antarctica and the other Southern continents should be established one way or the other. At the recent meeting of the British Association at Cardiff, it was urged by biologists, geographers, geologists, chemists, and physicists, on the initiation of Professor W. A. Herdman and Professor J. Stanley Gardiner, that steps should be taken to impress H.M. Government with the need of a national expedition for the exploration of the ocean.

Many of the outstanding problems were indicated. The changes in the physico-chemical characters of sea-water and their relation to the quantity of plankton must be determined, the differences in composition and abundance between tropical plankton and that of temperate and polar seas requires much investigation, and the distribution and action of denitrifying bacteria must be studied. These are but a few of the more intricate biological problems awaiting the oceanographer. Much has yet to be learnt regarding the breeding and migration of fishes and whales. The wide subject of bionomics of marine animals and plants is yet in its infancy.

These biological questions are intimately related to ones of direct economic value. As the pressure of the world's population becomes greater, the demand for food is more and more difficult to meet from land resources alone. Fisheries thus gain increased importance, and it is essential that the food resources of the sea should be investigated and measured as far as possible. So closely are fishery problems bound up with purely scientific research that no dividing-line is possible. Investigations in any physico-chemical or biological problem in the sea probably have bearing on the distribution and abundance of fish, and so for very practical reasons should be pursued.

An oceanographical expedition would also be concerned in determining, by means of sounding, the configuration of those ocean basins of which we have scanty knowledge. It would investigate the deposits covering the floor of the ocean. Unfortunately, there is no apparatus by which it is possible to penetrate the deep sea deposits and secure a sample of the rock *in situ* beneath. There is urgent need for scientific research in tidal phenomena.

Such an expedition is no light task. It requires careful preparation and a well-chosen vessel. Much time would be required—two to three years at least—because oceanographical operations are slow to carry out, and time must be allowed for failures and accidents. The vessel would require to refit and provision at various ports, delays which, of course, would curtail the time spent at sea. The *Challenger* was a corvette of some 2,300 tons with auxiliary steam power. She was specially fitted out for the work and proved most satisfactory. Officers and crew were supplied by the Navy, while the scientific staff were civilians. Similar collaboration is now required. The Admiralty, it is hoped, will be able to find a suitable ship in which accommodation and steadiness are greater essentials than speed. Deck space and laboratory accommodation are essential, and the vessel must be one suitable for work in all climates. In view of the cost of a vessel suited for magnetic work, it seems hardly necessary to conduct such research on board. Moreover, the work of the United States research vessel *Carnegie* has to a large extent obviated the necessity for this.

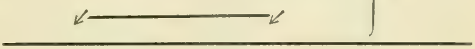
Considerations of economy in the use of Government resources are, or ought to be, of prime importance to-day, but economy can be carried too far if it causes the neglect of valuable scientific work, and allows research in the many problems of oceanography either to be neglected or conducted solely or chiefly by other countries. Moreover, it must be remembered that the ship itself would incur no cost except in fittings and appliances, while the officers and men, being drawn from the Navy, would simply be transferred from one branch to another of service.

Some general works on oceanography include: *The Ocean*, by Sir John Murray (Home University Library), 2*s*. 6*d*.; *The Depths of the Ocean*, by Sir John Murray and Dr. J. Hjort (Macmillan, 1912), 28*s*.; *Science of the Sea*, edited by G. H. Fowler (John Murray, 1912), 6*s*.; *Conditions of Life in the Sea*, by James Johnstone (Cambridge University Press, 1908), 9*s*. net; and various popular volumes on the *Challenger* expedition in addition to the scientific results. Reference may also be made to Professor W. A. Herdman's presidential address to the British Association at Cardiff (*Nature*, August 26, 1920), and to "The Scientific Investigation of the Ocean" (*Nature*, September 2, 1920).

Nelson's Approach at Trafalgar

By J. Holland Rose, Litt.D.

In this brief note on a great subject I have no space in which to describe fully either the antecedents of Nelson's last battle or his original plan of attack drawn up on October 9, 1805. The former may be found in all English histories, the latter is well set forth by Sir Julian Corbett in his *Campaign of Trafalgar*,[1] and by Sir Henry Newbolt in his *Year of Trafalgar*.[2] But I must briefly summarise that part of it which corresponded somewhat to the conditions under which Trafalgar was fought, viz. an attack from to windward. In his famous memorandum of October 9, Nelson sketched his plan as is here shown:



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[1] Published by Longmans (1910), 16*s*.

[2] Published by John Murray (1905), 5*s*.

E denotes the enemy's line of (presumedly) forty-six battleships. The three shorter lines denote the divisions of the British fleet (presumedly forty strong). The nearest British division of sixteen sail is to advance line abreast but slantwise, in the direction which I have indicated by the arrows, so as to attack and cut through the enemy's line beginning from the twelfth ship from his rear. "Some ships [says Nelson] may not get through their exact place, but they will always be at hand to assist their friends, and if they are thrown round the rear of the enemy, they will effectually complete the business of twelve sail of the enemy." This is quite clear. Nelson meant his lee division to advance line abreast (not line ahead, as James in his *Naval History* [vol. vi, pp. 470–72] perversely implies), each ship cutting through the hostile line as near as possible opposite her station, just as Lord Howe's fleet did at the glorious First of June (1794). Nelson's lee division was, in fact, to crush the enemy's rear, in a way that somewhat recalls Rodney's masterly concentration on the French rear off Martinique on April 17, 1780. As to Nelson's other division, also of sixteen sail, he gave very brief directions, merely stating that, with this force and the light division held in reserve, he would see to it that the enemy's thirty-four ships should interrupt as little as possible the efforts of his lee division against the enemy's rear.

He wrote little on this topic mainly because he meant to adapt his measures to circumstances, but also because he did not expect to attack from to windward. The hostile Franco-Spanish fleet in Cadiz was not likely to put out thence against a westerly wind; and he therefore looked forward to a battle only when the wind was easterly. Probably, too, he had outlined some similar scheme, for on October 1, when he propounded to them the "Nelson touch," some shed tears of joy and all approved. This was eight days before he penned the memorandum outlined above.

In one other respect that document does not help us much. Instead of having, as he then assumed, forty ships against forty-six, Nelson on October 21 had only twenty-seven against thirty-three, and therefore could not spare any sail to form the detached reserve division which he had designed to throw into the fray wherever it was most needed. He had also hoped for a stiff breeze which would admit of his closing with the enemy speedily. But at dawn of October 21, when he sighted the fleet of Villeneuve and Gravina some twelve miles to the east, the wind was very light at N.W., gradually slackening and veering in the afternoon to W.S.W. The direction was favourable for the approach; but the dropping of the breeze made it frightfully costly to the assailants. In this connection it should be remembered that bow-fire was then limited to a couple of light guns, and that the whole power of offence lay in the broadside of from thirty-two to fifty guns.

The enemy's combined fleet mounted 2,626 guns as against Nelson's 2,148 guns; and, though as many as nine of the enemy ships had drifted to leeward and could therefore not fire on the British during the approach of the latter, yet the twenty-four which were in line (or strictly speaking in crescent formation) had at first an enormous advantage over the assailants in case these adopted a perpendicular approach.

Finally, we must remember that the circumstances preceding the battle made Nelson extremely anxious to close at once. The combined fleet, when sighted on October 20, was leaving Cadiz and making for the Straits of Gibraltar, clearly with the intention of entering the Mediterranean. Later on it put about; but, when sighted again on the 21st, it was pointing southwards. Afterwards it "wore ship," i.e. put about before the wind, and then headed northwards as if to retire into Cadiz. We now know that this was not Villeneuve's aim; it was a skilful tactical move on his part. But to Nelson it appeared a sign of retreat to Cadiz. Now our great admiral was resolved to finish matters with that fleet, which he had chased to the West Indies and back. Not only professional pride but burning patriotism urged him on. In all probability he still believed that that mighty array was intended to cover Napoleon's projected invasion of England, for on September 14, when the *Victory* weighed anchor at Spithead, it was not yet known that the Emperor had given up that scheme and was wheeling his veterans from Boulogne towards the Upper Danube against Austria, and though, on October 6, Nelson received from home orders dated September 21, they too did not expressly name the collapse of Napoleon's hopes. Also there is no sure sign in Nelson's letters and despatches that he heard of the change of plan. At any rate, he was determined at all costs to prevent Villeneuve's retirement to Cadiz. The evidence both of Captain Blackwood and of Dr. Beatty is decisive as to his anxiety and eagerness on that topic. He ordered Blackwood, with the frigates, to complete the destruction of the enemy and not to think of saving ships or men; for (says Blackwood) "annihilation to both was his first object, and capture but a secondary one."

But how could he hope to annihilate an enemy of superior force on that brief autumn day? Mere cats'-paws were playing over the water. Even with royals and studding-sails set, he could not hope to close with the enemy before noon at earliest. On the other hand, the breeze failed them even more than him; and their ships, being close hauled, were forging ahead at little more than a knot an hour at the time of contact. This was especially the case at their van, and this fact partly excuses its commander, Dumanoir, for his extreme slowness in putting about to the help of the centre. From the outset it was clear that the battle must be slow and long. Nelson must have asked himself, Would the five and a half hours' daylight suffice for crushing the naval might of France and Spain and thereby ending all chance of invasion ?—an eventuality which still haunted his thoughts.[1] We all have read the account of his anxiety about Lady Hamilton and Horatia ; but who can measure the responsibilities of an admiral on whom depended the fortunes of Europe and the security of Great Britain ?

We can now understand the conditions under which Trafalgar was fought. They were such as to render Nelson's original plan or plans of attack inapplicable. Of course, he was too good a seaman to order rigid obedience, in all circumstances, to a programme drawn up twelve days before. To do so is perilous in land warfare and doubly so at sea, where conditions are ever changing. True, some of his captains afterwards stated that the plan had been followed ; but the weight of evidence is against this supposition. Indeed, much valuable time would have been taken up in forming the two lines, one behind the other ; and the advance of the front division in line abreast would have delayed the onset until lame ducks like the *Prince* and *Dreadnought* (both three-deckers) could have been anything like abreast of Collingwood's *Royal Sovereign*, fresh out of dock and the fastest ship in the fleet. Further, the marshalling of the second division behind it, and its filing off (almost certainly in line) on the larboard (port) tack in order to " contain " the enemy's centre, would also have been a lengthy operation. Speed being the dominating factor of the situation, Nelson formed his twenty-seven ships in two bodies pointing at the enemy. Luckily the *Royal Sovereign* and the *Victory* were fast sailers, and speedily headed their lines, the *Téméraire* and *Neptune*[2] (three-deckers) being a good second and third to Nelson's flagship. He had designed to place the most powerful ships in the van (though not in that order), and fortunately in four cases the heavy ships answered his hopes. Three other three-deckers, *Britannia* in his division and *Dreadnought* and *Prince* in Collingwood's division, were slow, the last not opening fire until three hours after the *Royal Sovereign*. The case of the *Prince* was extreme ; but it shows the great irregularity of the approach in the lee division.

The weather division, Nelson's, was not less spread out than that of Collingwood. Indeed, Captain Tizard's plan of the approach, in the Admiralty Memorandum on Trafalgar published in 1913, presents it as even more scattered, the *Minotaur* and *Spartiate* trailing off nearly four nautical miles astern of the *Victory*. Into the vexed question of the positions and distances of these and other 74's I do not propose to enter. What is certain is that Nelson ordered Captains Blackwood of the *Euryalus* frigate and Prowse of the *Sirius* to direct all captains in the rear to use any means in their power to reach the enemy's line as quickly as possible. Thus, while the best sailers crowded on each other at the front (Codrington of the *Orion* states that they pressed so close as to have to go bow and quarter line instead of direct line ahead), the laggards floundered along as best they could. The result, as appears in the best French and Spanish plans, is that the approaching British divisions figure, not as two lines, but two masses —*pelotons* is the term used by some French observers. Nelson had intended his weather division to be in line ahead, but, as has now been shown, he subordinated order and station-keeping to speed, the outcome being not the symmetrical column, as shown by Mahan and other writers, but an irregular formation only faintly approximating to line ahead.

Was the approach of Nelson's division perpendicular to the enemy's line ? That assertion has generally passed muster ; but French evidence renders it more than doubtful whether that division headed for the Spanish and French flagships, *Santissima Trinidad* and *Bucentaure*, eleventh and twelfth in their line. Captain Bérenger of *Scipion*, second ship in the van, distinctly asserts that *Formidable* (fourth in his line) first opened fire on the leading British ships, he second ; also that a cannonade took place during twenty-five to thirty minutes, *Scipion* being hulled several times. Rear-Admiral Dumanoir, in *Formidable*, states that the cannonade lasted forty minutes.[3] Now, even allowing for some exaggeration on the part of these officers, their testimony shows that Nelson actually engaged the French van. His move in that direction was not a feint, but a partial attack, his aim being as far as possible to cripple those eight ships before he ported his helm and ran down on the starboard tack towards the Spanish and French flagships. The French evidence further disposes of the legend that Nelson's leading ships fired not a gun before they cut the line. So does the log of the *Victory*: " At four minutes past twelve opened our fire on the enemy's van—in passing down their line." The fact is that Nelson utilised the crescent formation of the enemy to engage, at a distance of course, the enemy's van, and then approach slantwise his real objective. Thus the approach of the weather division was not perpendicular. Its leading ships were able to use their broadsides, first on the enemy's van and then, in a slanting approach, against his flagships and those following. The result was a mêlée which answered Nelson's expectations of leaving Collingwood undisturbed in his task of crushing the hostile rear.

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[1] Sir H. Nicolas, *Letters and Despatches of Nelson*, vol. ii. p. 87

[2] Alison's atlas appended to his *History of Europe* shows the *Neptune* as coming down from the north and engaging the hostile van as she made for the centre. This ship really was the *Africa* (64). The mistake has been copied into other historical atlases.

[3] Desbrière, *La Campagne Maritime de* 1805 : *Trafalgar*. Appendix, pp. 150, 155, 163.

To that trusty and beloved comrade Nelson had left full liberty in the control of the lee division. Its original formation, as we have seen, approximated to a line; but Collingwood signalled to some of his ships to spread out somewhat towards the hostile rear, the result being a partial resemblance to what is called a line of bearing. Here, again, the crescent formation of the enemy favoured (perhaps even suggested to Collingwood) this method of approach. Anyhow, some of his rear ships, notably the *Revenge*, sixth from his rear, spread out towards the enemy, and, sidling up, sought to cut through their line. Few succeeded because their units crowded up and in some cases prevented this last manœuvre.

In one other respect Collingwood's achievement was not quite so thorough as Nelson had hoped. Whether from a chivalrous desire to lessen the frightful burden about to fall on his chief, or because he did not see the three Spanish ships farther to leeward, or because his fighting instincts bade him attack the *Santa Ana* (120 guns), he made for that huge three-decker, the sixteenth from the hostile rear. Consequently his fifteen had to do, not with twelve, but with sixteen ships. Moreover, Collingwood's advance and that of his next ships was perpendicular; and it is a miracle that they escaped destruction. But British gunnery and bravery carried the day there as at the centre. With the details of the battle we are not here concerned. My object has been to set forth the tactics of Nelson's approach, to explain it by reference to the exigencies of the situation, and to correct one or two errors that have crept into widely accepted narratives of the battle. Above all, I wish to refer readers of DISCOVERY to the Admiralty Memorandum on Trafalgar (Eyre and Spottiswoode, 1913, 2*s.* 3*d.*), which gives the ships' logs and the other essential evidence concerning the greatest of all naval battles.

Louis Pasteur

DECEMBER 27, 1822—SEPTEMBER 28, 1898

The Discoverer of the True Origin of Fermentation and Disease

IN Pasteur we have the link between the scientist and the doctor, between the laboratory and the factory. The whole of his long life was devoted to the patient study of natural phenomena with a view to the discovery of their cause and the application of the knowledge so gained to the benefit of mankind.

The son of humble parents, he spent his early years at his father's tannery at Arbois, in the Jura, leaving home at the age of sixteen to go to the Barbet Boarding School in Paris. But here he became so homesick that his father fetched him away and he continued his studies at the college at Besançon. In 1842 he again went off to Paris, this time to teach in the Barbet Boarding School, at the same time attending Dumas' lectures on chemistry at the Sorbonne. A year later he entered the École Normale, with which he was to be associated more or less all his life. He was soon at work in Balard's laboratory collaborating with Laurent. His earliest researches were in the field of pure chemistry, known to-day as stereo-chemistry or the chemistry of space. Mitscherlich had called attention to two different kinds of tartaric acid, which could be distinguished in this way: one of them rotated the beam of polarised light, the other did not possess this curious property; but he had failed to give any reason for this phenomenon. After much careful examination of the crystals of tartaric acid, he noticed that they had small hemihedral faces, and that some of these turned to the right, others to the left. He set to work to pick out the different kinds of crystal one by one, and found that the left-handed crystals rotated the beam of light to the left, and the right-handed to the right. Although his work was being continually interrupted by one cause or another, Pasteur always returned to his beloved crystals, not being content till he found the lost inactive acid of Mitscherlich, known as paratartaric or racemic acid. Eventually he actually undertook a journey right across Germany and into Austria in search of this third kind of tartaric acid, which was said to have been seen from time to time in the sediments of the wine casks in those countries. His search was rewarded at last, though he had to go right down to Trieste for it, and in this way, among others, the foundations of the chemistry of space were laid.

His studies of the tartaric acids led him insensibly to the study of fermentation, and opportunely he was sent to the very centre of the French distillery trade at Lille as Dean of the Faculté des Sciences in that town. In the summer of 1856, a Lille distiller, M. Bigo, got into difficulties with the manufacture of alcohol from beet, and came to Pasteur for advice. Following his invariable practice, Pasteur started by performing experiments and making use of his microscope. He soon noticed that the microscopic appearance was very different when the fermentation was proceeding properly from what it was when things began to go wrong.

Soon after this he returned to the École Normale as Administrator, and there he continued his studies of alcoholic fermentation. It was not long before he came to the conclusion that where there was fermentation there was life, and that the germs of this life were borne on the dust of the air. This involved him in a discussion which was to last for many a long year to come.

To convince the heterogenists, those who still believed in spontaneous generation, Pasteur set to work to make numberless little glass bulbs with long-drawn-out necks ; into these he introduced infusions which would easily ferment ; he boiled them to ensure sterility, and sealed them up while hot. On opening his little bulbs in various localities, the air rushed in to fill the vacuum that had been formed ; the bulbs were then sealed up again and set aside to ferment if they would. His contention was that only those which had been opened in a dust- and germ-laden atmosphere would show signs of life. Not satisfied with the purity of the air of his native Jura, to make doubly sure he undertook a special journey to Chamonix and opened some of his flasks on the glacier. The results of these experiments turned out exactly as he had predicted they would, and he communicated them to the Academy in March 1880 : " If all the results that I have obtained until now are compared, it seems to me that it can be affirmed that the particles of dust suspended in the atmospheric air are the exclusive origin, the necessary condition, of life in infusions."

In the meantime he was pursuing his work on fermentation, and had discovered why it was that wine sometimes turned sour. This was due, he said, to a microscopic fungus (*Micoderma aceti*), which carried the oxygen of the air to the alcohol. He also showed that, by merely warming the wine to quite a low temperature, this fermentation could be inhibited and the wine kept in sound condition indefinitely. In Austria this process was already known as *pasteurisation* as early as 1865. It is amusing to read of Pasteur, while on a visit to Napoleon III and the Empress Eugénie, sneaking off to the Imperial wine-cellar with the head butler to see whether he could find any diseased bottles of wine.

In 1865 his work on fermentation was again interrupted, and he was sent to Alais to investigate the disease which was decimating the silkworms in this district. Again he relied on his direct experimental method and his microscope. He soon found the cause of the trouble and suggested a means of overcoming it, by examining the moths with the microscope after they had laid their eggs, and rejecting the eggs of those moths which showed the characteristic spots of the disease. In this way the healthiness of next year's worms was ensured. Some years later he had the satisfaction of seeing a huge silkworm factory named after him, with some sixty to seventy women, armed with microscopes, examining the moths.

In the summer of 1871, while staying at Clermont Ferrand with an old pupil, Pasteur paid a visit to the local brewery, and was astounded by the general state of ignorance of their art displayed by the brewers. He soon determined to make an exhaustive study of the subject with a view to furthering the French industry. To this end in the autumn he went off to London to visit the great English breweries. After the customary very careful microscopic examination of all the yeasts used to prepare the various kinds of beer, he was able to formulate the following maxim : " Every marked alteration in the quality of the beer coincides with the development of micro-organisms foreign to the nature of true beer yeast."

Hitherto Pasteur's discoveries had not led him into the field of medicine, though it was obvious that sooner of later he must attack the problem of the origin of disease. To understand fully what Pasteur did for humanity, one must clearly realise, firstly, that medicine was at this time little short of what would now be regarded as quackery, and, secondly, that the scientist was looked upon almost with contempt by the medical profession. The acknowledgment by Lord Lister of his indebtedness to Pasteur was in itself no mean triumph for this humble seeker after truth.

The ravages of anthrax among the herds of France gave Pasteur his opportunity. Though he was not actually the discoverer of the anthrax bacillus, he did more to elucidate the mysteries of this disease than anyone else. Again attacking the problem with his two weapons, experiment and the microscope, he showed in the first place how pure cultures might be made in a sterile broth ; secondly how essential it was to take the infected blood from an animal recently dead of the disease for this purpose, for, if not, the bacillus of septicæmia would also be present to complicate matters. He even succeeded in separating the two, showing how one was aerobic and the other anaerobic (capable of living without air). Having obtained the pure culture, he showed that, if it were injected into a healthy animal, all the symptoms of the disease would be reproduced and eventually the animal would die. If, however, the culture was kept at a temperature of about 42° C. for several days it lost its virulence, and when injected into the healthy animal it now only gave rise to a benignant malady which had the property of preserving it from the virulent form. Thus was the anthrax vaccine discovered. Long years of study and hundreds of experiments were needed to arrive at these results, and even then many more years were spent in convincing the veterinary surgeons of the truth. A great public demonstration on a large number of sheep with proper controls was not even enough to convince the most sceptical.

In the meantime Pasteur had been making a study of chicken-cholera, and had isolated its bacillus, prepared the vaccine, and proved how easy it was to render the birds immune.

Pasteur, his experiments and his microscope, next invaded the maternity hospitals of Paris, determined to find out the cause of puerperal fever. He soon detected and isolated the microbe that was causing all the trouble. In a discussion on the subject at the Academy of Medicine, one of his colleagues was enlarging on the causes of the fever, when Pasteur interrupted him: "None of those things cause the epidemic; it is the nursing and medical staff who carry the microbe from an infected woman to a healthy one." On the member replying that he feared the microbe would never be found, Pasteur went to the blackboard and drew a picture of the chain-like organism, saying, "There, that is what it is like." After this his suggestions as to sterilising the instruments, bed linen, etc., were adopted, with astounding results; soon puerperal fever almost ceased to exist.

Swine fever was next studied, the germ isolated and the vaccine made, and Pasteur was now, in 1880, turning his thoughts to the study of rabies, but it was not till 1884 that he seriously started his campaign against this fearful scourge. The problem here was no simple one; in the first place it was not known where the offending germ was localised, and the disease, hydrophobia, communicated to man through a bite was not the same as that from which the animal was suffering. After countless experiments on mad dogs, it became evident that the virus had its seat in the nervous system and particularly in the brain. Without entering into detail as to these extremely delicate experiments, let it suffice to say that the virus thus localised could be injected into healthy animals, and all the symptoms of rabies were reproduced. The problem now was how to prepare the vaccine, how to attenuate its virulence. The microbe had not been discovered, in fact it has not yet been tracked down. After many failures, it was at last found that a small portion of infected medulla could be dried over potash for several days in a sterile tube, and when dry could be powdered and mixed with water. This solution, when injected into the healthy animal, rendered it immune from the disease, as Pasteur was able to demonstrate experimentally beyond all doubt. Obviously it would be impossible to render every dog immune from a possible attack of rabies. Here was a fresh problem to be solved, the problem of obtaining prophylaxis of rabies after a bite.

It was not till the summer of 1885 that Pasteur began to feel sure of his ground. Monday, July 6, of that year was a memorable day, for on this day the little Alsatian boy Joseph Meister, who had been bitten by a mad dog, was brought by his parents to Pasteur's laboratory. After much deliberation, Pasteur at last decided to try a series of inoculations of increasing strength. It was an anxious time, for though the experiment had ofttimes been repeated with success on dogs, this was the first time he had dared to try it on a human being. The experiment was a perfect success and little Joseph was soon able to return home, his life saved by the antirabic vaccine. After this and other successes, it became obvious that some sort of central bureau would have to be established where treatment could be given in cases of bites from dogs suffering from rabies.

It was for this purpose primarily that the Pasteur Institute was founded, and to this day patients from this country have to journey there for treatment. Pasteur lived to see operations in full swing in this new establishment, although his health in his last years did not admit of his taking as active a part as he could have wished in the researches that were being carried on.

NOTE.—The reader will find in *The Life of Pasteur*, by René Vallery-Radot (English translation by Mrs. Devonshire, Constable & Co., 1919, 10*s*. 6*d*.), a most intimate and readable account of this great discoverer's life.

EDWARD CAHEN.

New Interpretations of Romanticism

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A HUNDRED years ago literary Europe was Romantic; Romanticism was the watchword of progress in poetry. And yet, at the beginning of the twentieth century, we are still very much in the dark as to what this Romanticism really was. As early as 1824 a French critic sighed that Romanticism had been so often defined; and we have not yet succeeded in defining it. In recent years a large number of books have appeared in England, France, Germany, and Italy dealing with this great period of literary history, and all trying, more or less directly, to arrive at some kind of definition, trying to discover what were the really vital and germinative elements in the movement. It is something of an enigma that its doctrines should have tinged the whole literary evolution of Europe and made the nineteenth century—the century of apparently un-Romantic material progress, although of scientific discovery beyond the wildest dreams of the Romantic generation itself—the most Romantic of all centuries in poetry. A certain confusion as to the meaning of the word existed from the very beginning;

the early German Romanticists called their school "Romantic" in defiance of a popular meaning of the word which they did not at all wish to attach to it; to them Romantic meant rather of the nature of the Romance or Latin nations than an imitation of mediæval romances of faery. As a literary school they were, in fact, far less romantic, in the popular sense of the term, than the generation that had preceded them. And when Madame de Staël, in her great book on Germany—a book, by the way, that was written with the leader of the German Romantic School at her elbow—opened the sluice-gates, and German influence poured across France and the rest of Europe, the undefined term Romantic became a kind of household word everywhere. To make the confusion worse, no attempt was made in other lands to employ it for the same thing which the Germans meant by it. With perhaps a surer literary instinct, the French and ourselves recognised what the Germans were unwilling to admit, a kinship between the new tendencies and the individualistic revolt associated with Rousseau, the revival of an interest in nature and mediævalism which had taken place some decades before there was any talk of a Romantic school at all. Romanticism in lands outside Germany thus went its own way and grafted itself on earlier movements; each people worked out for itself a conception of Romanticism suitable to its own needs. Thus the German Romantic School is one thing, the École Romantique in France quite a different thing; different, too, is the Romanticism of Italian literature, and certainly different our own somewhat vague conception of Romanticism as a kind of general antithesis to all that is not bound by classical rule. So complicated is the problem that one might well give up as hopeless any attempt to correlate these various forms of Romanticism. The analogue, for instance, of German Romanticism in English literature is—apart from Carlyle, who is obviously an immediate representative of the German Romantic mood—not our so-called Romantic writers, Scott and Byron, Coleridge and Wordsworth, but Ruskin and the pre-Raphaelite Brethren; the Romantic poets in France have nothing in common with either group, their nearest analogue being possibly their own sixteenth-century literature; while so despairing is a recent Italian critic of finding a common basis that she plaintively questions whether there is any Romantic school in Italy at all. Correlation is clearly not to be attained on the lines of precise national definitions. Other critics have gone to the opposite extreme and started from the widest possible conception of Romanticism. This is especially true of the Italians, as witness Signor Borgese's most stimulating volume on the history of Romantic criticism in Italy. But we doubt whether a common basis for the various national developments is to be obtained by going back deep into the eighteenth century.

The tendency of recent works on Romanticism—and the chief books we have in mind are enumerated at the end of the present article—has been to try to get beneath the surface, to discover, if not a common definition applicable to all literatures, at least one common denominator in the Romantic equation. Several of these new works contain a definite effort to discover the esoteric secret of the Romantic faith, to understand the extraordinary vitality that made Romanticism such a power in literary Europe. In Germany—and, after all, Germany was the home of the Romantic "idea"—there has been in the past ten or twenty years a large mass of painstaking investigations into the doctrines of Romanticism; these investigations have cleared away old prejudices and established new values. Gradually Friedrich Schlegel has emerged from the mist that formerly enveloped him, as the great inspiring force of the new movement; while his better-known brother, August Wilhelm, is now seen to have been but a populariser of Friedrich's ideas. It has become clear that the outer paraphernalia which we commonly associate with the movement—the ruined castles and mediævalism, sham and real, the moonlight and sentimentality—had little to do with the stability and potency of Romanticism; these were merely a heritage from an earlier period, and of themselves not possessed of any redeeming virtue. Literary Romanticism, as is coming to be understood in Germany, is by no means in antagonism to what we usually regard as essentially classical characteristics, such as unities, regularity of form, and poetic decorum. On the contrary, the German school has room for classicists as well as contemners of classic form; it is a widehearted cult based on individual freedom. Recent French critics of Romanticism have taken a somewhat different line; they, too, have been looking beyond the individual phenomena and endeavouring to discover the essential root of the matter. To M. Lasserre, for instance, whose brilliant if a little specious work on Romanticism caused considerable commotion a few years ago, Romanticism is an evil thing and has its source in Rousseau; the object of his work is, while insisting on the unbroken continuity of literary evolution from the eighteenth century, to refute accepted estimates of the French Romantic movement. The Italian investigators, too, have shown much searching of the heart, and are beginning, somewhat discouraged, to see in the so-called Italian "Romanticismo" merely a kind of outer, inessential shell, an imitation of Sir Walter Scott, and a blind faith in that "Bible of Italian Romanticism," Schlegel's *Lectures on Dramatic Literature*; in other words, a movement without any deeper roots in Italian soil. And we are not sure whether Romanticism in Spain has yet been seen in any other light than as an imitation of the French school coupled with a fervid enthusiasm for Byron. With ourselves, and especially in America, a careful revision of our Romantic age—as in Professor Elton's illuminating volumes, which take ample count of the contemporary Continental movements—has gone hand in hand with investigations into the social aspects of the Romantic ideas, and new theories on the lines of M. Lasserre's, which seek the fountainhead, for good or for evil, in the eighteenth century. Recent American critics like Mr. Elmore More and Professor Irving Babbitt—and Americans have perhaps some advantage over us Europeans in being, as it were, at a greater distance from the fray—have gone further, and, like M. Lasserre, emphasised the evil effects of Romanticism as an undesirable persistence of Rousseauism. Thus one might say, at a first glance, that these various investigations, so far from being steps in the direction of correlation, are centrifugal in their tendencies.

And yet it seems to us that this critical literature, even when it is accentuating differences, may help us to discover a common bond, to link up the widely different movements in different lands. For one thing, these new critics have discredited as a common basis of interpretation the older formulas which used to pass muster. Gautier and Heine saw in the revival of the Middle Ages the essential feature of Romanticism; and, of recent critics, Professor Beer on the whole agrees with them ; in England the phrase " renaissance of wonder " was long a favourite formula to explain the age; while Brunetière, taking a more philosophical standpoint, proclaimed the ultimate basis to be the awakening of the ego, the spirit of individualism. We have been studying this recent critical literature with a view, not to learning the distinctive features of each nation's Romanticism, but to discover a formula for the deeper impulse that is clearly common to the whole spiritual upheaval. And the formula we would deduce from these investigations is expressed neither mediævalism nor by individualism, but is most conveniently summed up by the word " conciliation." What the romantically—and we use the word in its specifically technical sense—minded poets and critics in all lands aimed at was a conciliation over wide areas of social and artistic activities. They resolved to be done with the watertight-compartment systems of literature, with the barriers that might on no account be crossed, the eternally valid laws, be it in life or in poetry ; they introduced into literature a conception of relativity and interdependence. Romanticism in all lands stands for a conciliation of life and poetry: hence its repudiation of a classicism which had become divorced from reality; of the historic past with the living present : hence the revival of mediævalism ; for a merging of music in poetry, religion in poetry, philosophy in poetry ; in other words, for a " universalising " of poetry in Friedrich Schlegel's phrase. The poetry of the untutored people stands, in the Romantic mind, as high in honour as—perhaps higher than—the polished verse of the schooled poet. The domain of the man of letters is as wide as life itself: all problems, all aspects of human life, even those that are dark and repulsive, are open to him. Hence M. Pelissier is right in proclaiming the essentially romantic character of the modern realistic movement in France. Moreover, the spirit of conciliation naturally gives every freedom to the individual poet to speak the faith that is in him. Hence the essentially individualistic trend of the movement which Brunetière emphasised.

But the vital force was not, it seems to us, individualism ; individualism is insufficient to explain all, including some of the most significant, phenomena of Romanticism. The catholic quietism of the early Romanticists, no less than their political obscurantism—for was not the Metternich régime a Romantic creation? —cannot be explained as a product of unrestrained individualism. The awakening of the little literatures of Europe to new vigour, the interest in the poetry of dialect—clear products of the Romantic movement—are less to be explained as an assertion of individualistic rights than as an expression of that conciliatory spirit which sees in the literature of all peoples one great harmonious whole. Conciliation and universalism in matters spiritual are apt to break down when they have to deal with concrete social and national problems ; here lies the justification—so far as it can be justified—of Professor Babbitt's arraignment of Romanticism, not, we think, in what Romanticism owes to the doctrines of Rousseau.

Such seem to us the present stage of the Romantic controversy, and the conclusions which we are entitled to draw. We are, however, still far from that fullness of knowledge of the movement in its comparative aspects which would make a history of European Romanticism, regarded as a whole, a fruitful undertaking.

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The Independence of Psychology[1]

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In his address to the Subsection of Psychology last year, Dr. Rivers dealt with recent advances in our understanding of mental disorders and their treatment. Since the war, my immediate interests have been turned from this to another field of applied psychology, namely to industrial psychology: but as my work in it has lain rather in the direction of organisation than of personal research, I have decided to leave this subject to the contributors of the seven papers bearing on it, which will later come before this Subsection, and to turn to a broader problem for my address—the general position of psychology at the present day, particularly in relation to physiology. In the choice and treatment of this theme I have been influenced, first by the unanimous opinion of psychologists that the time has come for the institution of a separate section of this Association devoted to Psychology, and secondly by the fact that a discussion between physiologists and psychologists has been arranged to follow my address, in order that this opinion may be fully debated.

It is perhaps superfluous to point to the growing interest in and importance of psychology during the past four or five years, whether as illustrated by the recent increase of membership of the British Psychological Society to upwards of six hundred persons, by the noteworthy applications of psychology to warfare, medicine, education, industry, and other social problems, by the recognition of psychology as one of the subjects for a Degree in Science at several of our Universities, by the establishment of University Boards of Psychological Studies, or by the striking increase in the number of students attending lectures and engaged in research in psychology since the war.

Psychology is now recognised as a distinct subject of study, with methods and aims of its own, which are quite different from those of philosophy or of physiology—the two studies to which it owes most, for its inception and for its emancipation respectively. Freed from its long tutelage under philosophy, it has at length been able to assume the character and the aims of *Modern* Science, which, as Dr. Singer has recently pointed out,[2] unlike the Science of the Greeks, did not arise as an offspring of philosophy, but only later began to form an alliance with it. As a modern science, psychology is able to lay aside such metaphysical problems as the relation of mind to body, with its implications of materialism, idealism, parallelism, interactionism, determinism, and free-will. The views which psychologists may hold on the problem of the mind-body relation will interfere no more with the progress of scientific psychology than the conflicting views on vitalism and mechanism interfere with the progress of physiology. There are many who believe that such problems will never be solved by the methods of natural science. But all are agreed that, whatever opinions an investigator may hold in regard to them, those opinions need not hinder him, any more than his religious opinions, from advancing his subject by scientific research.

Freed also now from the scientific leading-strings of physiology, psychology is able to devote itself purely to the study of mental processes, their functions, relation, and natural history, the results of their synthesis and analysis, their growth and decay in the individual, their comparison and evolution in the race, species, and genus, and their abnormal variations, in excess or defect, due to heredity, disease, drugs, or injury. Psychology now studies mental processes for their own sake, neither because of their interest for metaphysicians in support of some wide-cast theory of knowledge, of reality, or of the universe, nor because of their interest for physiologists who seek to determine the functions of living substance.

Most of us, not all perhaps, have passed beyond the stage of crass materialism, when the mind was regarded as the "function" of the brain—secreted by nerve cells just as the cells of the liver secrete bile. We now recognise that it is the nervous impulse, not the mental process, that results physiologically from the activity of the neuron,[3] and that it is the nervous impulse which is the subject of study of neural[4] physiology. It is, of course, always interesting and often valuable to correlate nervous and mental processes; but, so long as we are ignorant of the nature of their interrelation, the two must be kept separate and not confused. Anyone who speaks of a sensation ascending a nerve, or of a thought passing through the brain, at once betrays his incompetence.

The independence of psychology and physiology is further illustrated by the different sources from which the former has obtained its recruits. Neither Francis Galton, the father of experimental human psychology in this country, nor Lloyd Morgan, one of the fathers of experimental animal psychology, could be called physiologists. Nor, on the Continent, had the versatile Fechner or the physicist Mach received physiological training. Moreover, some of the most recent advances of psychology, due especially to the work of Janet,

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[1] An opening address to the Subsection of Psychology at the Cardiff Meeting of the British Association, 1920.

[2] In his Inaugural Lecture, *Greek Science and Modern Science.* London: University of London Press, 1920.

[3] The nerve cell with its processes.

[4] Relating to the nervous system.

Freud, Jung, and Morton Prince, have been made quite independently of physiological foundations and physiological considerations.

Let us realise, then, that the nervous system can be studied for its own sake by the physiologist, that the mental system can be studied for its own sake by the psychologist, and that the relation between neural and mental processes is the concern of a fascinating border science, physiological psychology, in which physiology and psychology are deeply interested, from which each may (with due precaution) derive considerable help, but in which each is only secondarily concerned.

When, nearly twenty years ago, I began to teach experimental psychology, it was generally confused with the physiology of the sense organs, and reaction times. During that period I have naturally adhered closely to the general lines of my predecessor and teacher, Dr. Rivers, who was probably the first, in Europe at least, to introduce a really systematic practical course of experimental psychology into the laboratory. His pupils began by studying the simplest and most abstract processes, sensations—proceeding thence to illusions, memory, and so on. To-day I feel by no means sure that this is any longer the best method of beginning the subject, so great has been the advance within recent years in the experimental investigation and in the scientific observation of other mental processes. The objects of the teacher of psychology must be first to train his pupils in discerning the varied material with which they will have to deal, and next to train them in scientific method. I am disposed to think that sensations afford a less easy and less interesting theme for introspection than, say, ideas or thoughts. I believe that, at all events in the biological sciences, of which psychology forms a part, it will often prove a mistaken procedure to begin with the study of apparently the most simple object, which is often that which we have come to know last, about which we know least, and which is often, by reason of its very simplicity, the most abstract or remote from everyday experience. We owe this principle of instruction, I suppose, to the age of scholasticism, which confused the formal laws and operations of Logic with the mental processes actually employed in reasoning, and the rules of grammar with the speaking of language. We are at length recognising that, inasmuch as the grammar of language and the scales of music were not formulated until ages after speech and melody had been in use, a foreign language should not be taught by first learning the basic rules of grammar, nor should music be taught by beginning with scale practice. The last to be abstracted cannot be the first to be taught. For this and other reasons I would suggest that the study of psychology should begin with a preliminary survey of the more advanced mental processes, the more familiar, the more interesting, and the more alive in tendency to action and in wealth of introspection : I mean the flow of thoughts. The prominence of individual mental differences would be thus forced early on the student's notice, and at the outset he would be trained in analysis and in recognising the enormous importance of affection, emotion, conation, of instinctive and unconscious mental activity, and in the effects of suggestion, foreknowledge, etc. Having thus learnt the general groundwork of his subject, the student would then receive instruction in the psycho-physical and statistical methods, a knowledge of which is so essential for the avoidance of pitfalls in psychological experiment. It is mainly due to their ignorance or neglect of the psycho-physical methods that those experienced in research in other branches of natural science are apt to fail so egregiously when they attempt to carry out investigations involving the action of mental processes, e.g. in colour vision, in mental fatigue, and most strikingly in so-called "psychical research," which has fallen almost wholly into the hands of the psychologically untrained. The psycho-physical methods are most easily practised and mastered in the sphere of sensory experience.

Before he begins the study of psychology, the student should have learnt the elements of physics and biology, and he should have then attended a course of elementary physiology and a course of elementary philosophy, so as to avoid subsequent confusion of scientific psychology with either, and so as to recognise the deep interest of psychology in both.

There is a correspondence, but not, I think, any connection, between the importance which experimental psychology at one time attached to the study of sensation and the great stress laid by philosophers, in the pre-experimental phase of psychology, on the sphere of the intellect. In the world's history, philosophical speculation has always preceded scientific experiment and analysis. Natural science, which demands greater patience, self-control, and impartiality, has only made real progress during the last two or three centuries, whereas philosophical thought and speculation have been able to flourish from remote antiquity. The subject-matter of psychology formed but a fraction of the wide sphere of interests of the metaphysician, who considered himself qualified and in duty bound to philosophise on every branch of knowledge. It is little wonder, then, that the framers of such world-wide hypotheses overlooked psychological facts that did not easily fit into them, and neglected to observe those which were not of immediate interest. They laid little stress on instinct and suggestion : their consideration of the unconscious was practically limited to the recognition of habit and of the mental "dispositions" left behind from previous experience. Somewhere the "will" had to find a place between cognition[1] and action: in a vague way they supposed willed action to have been developed out of impulsive and ideo-motor action through self-activity, but their reflections (often prejudiced, doubtless, by conceptions of free-will, moral responsibility, immortality, etc.) carried them hardly further than this. The emotions were introduced haphazard into their psychological scheme, without any clear relation to the cognitive, affective, and conative divisions into which they had already divided their subject.

An escape from this "intellectualistic" atmosphere was offered by the conception first developed by our fellow-countryman, Shand, of the nature and importance of what he called "sentiments," and a little later by the publication by McDougall of his *Introduction to Social Psychology*[2]—in which (as Stout had previously done) he included Shand's ideas in his own elaborate treatment and classification of the instincts and emotions. McDougall insisted on the enormous biological and social importance of the emotions, on the closeness of their relation to instinctive and conative action, and on their characteristic, often irresistible, force. Shand had brought cognition into fusion with emotion under the name of "sentiment," which he gave to a past experience that had by association with emotion left behind a cognitive, set in a background of emotional, disposition. Thus a cognitive experience, whether it be a percept such as of one's pipe, or a concept such as of one's native land, comes to have "value" and to be endowed with emotional experience and force. One's pipe, when broken, at once produces the emotion and the expression of sorrow; one's patriotism, when put to the test, at once evokes attack or defence and the emotions of anger, tenderness, etc. A sentiment is thus a system of past ideas or percepts, set in a halo of definite emotional dispositions with which they have by past experience become associated. A sentiment comes to have far greater force than a mere idea or percept, devoid or such emotional halo.

Still later Shand's notion of sentiment received important and independent development at the hands of Freud. Psychologists had already recognised that mental processes tend to recur, not only by virtue of their previous association with other mental processes, but also by virtue of their inherent and retained energy. The importance of association had long been known, and had somewhat retarded full recognition of the process of "perseveration," the tendency of past experiences spontaneously to recur, to force themselves again into consciousness by virtue of their inherent indomitable energy. Such perseveration occurs especially in the case of exciting emotional experience. One who has just fallen in love or suffered a bereavement is powerless, try as he will, to avoid the intrusion of the person, the scenes, and the emotions related to his new experience, into his workaday life. But when the system of ideas with which such an emotional disposition is connected becomes inhibited or "repressed," the emotion only gathers force as it meets the opposing force. The system can no longer directly express itself in action, nor can it rest relatively in peace as a "sentiment." Coincident with its repression, it becomes a "complex."[3] The repression or inhibition occurs through an incompatibility or a conflict that would be involved, through an unpleasantness and discordance that dare not be faced. For this reason, as a complex, it becomes consciously or unconsciously "repressed" (as we say) into the unconscious. It may lie buried there in total oblivion, absolutely irrevocable save through the agency of some special mental exploration, e.g. by psycho-analysis or under hypnosis, which succeeds by reducing the repressing force. Or the comlex may be imperfectly repressed. In that event, the energy of the emotional part of the repressed complex may be expended through its "dissociation" from that system of ideas or percepts with which it was originally connected. The emotion may then escape in the form of unreasoned emotion, say of fear or anxiety, unattached to any special object. Or, more often, it may become attached to some other, more or less analogous, object. The original scene, when the complex is imperfectly repressed, may itself recur whenever inhibition is reduced as in sleep; but even in dreams the scene may recur only in a distorted or symbolic form, in order, apparently, to elude the forces of inhibition successfully.

Into the unconscious we are perpetually, more or less unconsciously, banishing percepts and ideas which are incompatible and discordant with our general mental life. From the unconscious emerge not only complexes or parts of complexes which have been thus repressed, but also new formations, e.g. the creations of the genius or inventor, which are then presented to his conscious mind for judgment, approval, and elaboration.

Thus the importance of the unconscious becomes at least as great for psychology as that of the conscious. At first sight, the critical psychologist may hesitate to regard the unconscious as "mental," preferring to consider it in terms of "physiological" traces, or dispositions, left behind in central nervous tissue, which can only be termed "mental" in the presence of consciousness. But the results of investigations by psycho-analysis and under hypnosis, of studies of disordered, alternating, and multiple personality, automatic writing, etc., must finally force the impartial psychologist to endow the unconscious, like the conscious, with a mental aspect. They convince him of the necessity for displacing consciousness from the pinnacle it has hitherto occupied in psychology. Unconsciousness is no longer a mere "fringe" around the field of consciousness. It becomes the basis, the foundation on which consciousness depends—the nourishment from which it draws its very existence. We begin to see the "superficiality" of consciousness, and to recognise that almost any mental event may happen with or without the accompaniment of personal consciousness. Such consciousness has been evolved to facilitate choice between alternative reactions—to bring the entire unity or personality of the organism into more complete relation with its environment. Where only one reaction is possible, the action remains a reflex, and no sensation or impulse need be felt. Where the reaction is to some extent modifiable, the action becomes instinctive—emotional activity, impulsive tendencies, and crude blurred sensations being experienced. Where alternative responses are desirable, discrimination becomes acute and a larger and more dominating self develops—a dominating apical system which endeavours to permit of action only after it has given its consent or sanction: thus arise the beginnings of will.

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[1] The act of apprehending.

[2] Published by Methuen, 15th edition, 7s. 6d.

[3] A system or group of experiences bearing upon one central idea, the whole or part of which system is repressed.

We now recognise that the consent and sanction of the self to a volitional act are but the reaction of an apical mental system to the sum total of conflicting and favourable tendencies to action; that every seemingly unaccountable thought and action are traceable to a "cause," and that the "reasons" offered by the self for a course of thought or action are often mere illusory explanations, unconsciously later coined as excuses for actions and beliefs which in reality are dictated by the lower and more fundamental conative tendencies of instinct, emotion, unconscious suggestion, and very early experience, working themselves out by their own perseverating, "determining tendencies." These changes of outlook mark an enormous advance in the progress of psychology; but we may well ask, what immediate interest have they for physiology, how have they been dictated by physiological knowledge, and how can they be absorbed into it?

The truth is that these modern developments of psychology have taken place entirely independently of physiological considerations. We have no idea of the actual neural seat or of the physiological conditions of consciousness. We do not even know what physiological changes occur when a conscious act, by sufficiently repeated experience, becomes an unconscious habit. There is no reason to suppose that we have here a transference of physiological activity from higher to lower neural levels. All our knowledge rather points to the conclusion that under certain conditions consciousness may be present, while under others it may be absent, when the same nervous areas are thrown into activity. We have indeed no reason to believe that the so-called sensory or sensori-psychic areas[1] are the "seats" of conscious activity at all, although these centres are doubtless indispensable for its manifestation. Just as, if trains must pass through a certain junction to reach their ultimate terminus, we do not identify the junction with the terminus, so we are not justified in identifying cortical centres with the seats of conscious activity.

Physiology can offer no counterpart to the known psychological facts of perseveration, of the irresistibility of emotional force, or of its sublimation to higher and still higher forms. Nor is she concerned in the recognition of two main currents of psychical energy, the one directed outwards towards the external world, the other turned inwards and lost in the intricacies of day-dreaming and concentration on internal experience. These contrary currents of psychical activity have received the names of "extraversion" and "introversion"; and the recognition of their difference and of their pathological variations has thrown much light on the psychology of functional nervous disorders and the insanities. But for the physiologist they have, for the present, at least, no meaning or interest whatever.

Similarly devoid of expression in physiological language are our conceptions of psychical "dissociation" and "regression"; the first, the splitting up of the unified conscious stream into smaller, more or less independent fragments, and the possibilities of co-consciousness, i.e. the coexistence of two or more such fragments in the mind; the second, the backward or involutionary path of mental processes to more infantile conditions.

As I have already urged, the psychologist studies mental processes for their own sake. His remarkably detailed and elaborate researches into the conditions of association—the rate of learning and forgetting, the results of distributing a definite number of repetitions over a longer or a shorter time, the effects of learning a given quantity of matter by sectional or by entire (global) repetitions, the temporary inhibiting or facilitating influences of subsequently learnt associations over earlier ones, the apparent indestructibility of (at least, emotional) memories—are all investigations which the psychologist has carried out and successfully applied in practice, despite our utter ignorance of the physiological basis even of memory. The analysis of the mental work curve, e.g. the recognition, and the attempts at measurement, of the opposing factors of practice, fatigue, incitement, spurt, and settlement, the influence of drugs on mental work, the relations of sensory imagery and speech to thought and of meaning to imagery and perception—all are quite independent of our knowledge of any accompanying nervous activities. Even if we did know the functions and the conditions of activity of every particle of nervous substance within the body, the need for psychological investigations would still remain. Physiology can never describe a mental process, but only the neural process with which it is somehow correlated.

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[1] Parts of the brain which are definitely associated with sensation and perception.

The independence of psychology is even still more evident in its applications. Psychology has now reached the stage of being an Applied Science. In medicine, it has established a new point of view in the treatment of certain mental and nervous disorders, the "psychogenic"[1] character of which has now in many cases been clearly shown, and the cure of which must therefore be conducted primarily from a psycho-therapeutic standpoint. In education, the importance of considering individual interests and mental differences, of investigating the effects of formal training and the relation of general to specific abilities, and of adapting the curriculum to the psychology of the child instead of to that of the adult, has become more and more clearly recognised. In industry, applied psychology is determining the most economical methods of work, alike as regards the best movements to be learnt, the best distribution of periods of work and rest, and the foundation of mental tests which will select those best fitted for different kinds of work. Unfortunately, some of the most ardent advocates of the applications of psychology to education, industry, and medicine have themselves received inadequate training in pure psychology. The consequent initial result has been to establish narrow "schools" of psycho-therapeutics, education, etc., and an uncritical hero-worship of these worthy pioneers. But the more judicially minded psychologist may easily forgive the blind enthusiasm and antagonism which such revolutionary changes have had to meet.

In jurisprudence, psychology is fast making its influence felt. The hitherto unjust criteria of criminal responsibility are being modified in the light of increasing psychological knowledge. The value of legal evidence is being considered in the light of recent psychological experiments on the degree of accuracy, detail, and subjective assurance with which an experience is revived, on the influence of time, suggestion, etc. In art, psychology is founding an experimental science of æsthetics. In biology, psychology has done excellent work on the study of the behaviour of animals, and in ethnology on the study of different races. In religion, in economics, in history, in linguistics, it is likewise fast proving its value. But how are all these instances of the applications of psychology of interest for physiology?

I have left untouched one class of research in which it might be supposed that psychological knowledge has been dependent on physiological experiment. I refer to the effects of experimental, accidental, or morbid lesions[2] of the central and peripheral human nervous system upon mental activity. In particular I refer to the striking researches of Henry Head and his collaborators, Rivers, Gordon Holmes, and Riddoch. But these researches are to my mind primarily psychological, not physiological. They have involved the careful application of psychological tests and psycho-physical methods to individuals whose nervous system is no longer intact. They demand psychological rather than physiological training for their final interpretation. Indeed, they have taught the psychologist to be chary of the evidence adduced in the field of physiological psychology. Thus Head's most recent work on aphasia (now on the eve of publication) has given the final death blow to those diagrammatic schemes of speech centres, with their visual, auditory, and kinæsthetic[3] memory centres, which physicians so long believed they had scientifically demonstrated and psychologists credulously accepted, under the stultifying influence of bygone notions of the storing up of images in special centres, the mistaken confusion of imagery with meaning and of thought with language, and the erroneous conceptions of separate watertight mental faculties.

Head's earlier work has revealed the complex nature of apparently simple processes, and confirmed the psychologist in his growing disbelief in the sufficiency of ordinary introspection, and in his realisation of the importance of the lower unconscious regions for the effective activity of the higher. It has also afforded valuable examples of the acceptance, inhibition, or fusion of compatible or incompatible sensory processes and of the control exercised by higher over lower mental systems.

Nevertheless, the exact significance of many of the results of these investigations for psychology is quite uncertain. Because a man walks with a certain characteristic gait when certain nervous paths are affected by disease, it would be fallacious to assume that this gait illustrates a primitive form of progression. So, too, because in certain lesions abnormal mental states make their appearance, one must not necessarily infer that these have had an independent existence in man's normal intact ancestry. Again, it would be unsafe to assume, because the existence of two forms of cutaneous[4] sensibility is indicated by observations chiefly made during the regeneration of divided sensory nerves, that these two systems have separately originated at different periods during men's past evolution. It may well be that the protopathic and epicritic[1] systems have been differentiated in man from a single cruder system in which neither can be separately recognised. From a physiological aspect, the distinction of protopathic from epicritic sensibility is, so far, devoid of neurological basis: we cannot say that the one system is related to one set of nerves, the other to another. At the same time, by such investigations physiology has learnt of the existence of a diffuse "massive" reaction in the divided human cord, the progressive grouping and regrouping of various afferent impulses at different levels of the central nervous system, the probable localisation of primary sense qualities, and of crude pleasure, displeasure, and emotion, in the thalamus, and of the more complex sensory and higher mental characters in the cerebral cortex.[2] In the cortex, indeed, they strongly suggest an entirely novel conception of the principles of localisation.

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[1] Having psychical causation.

[2] Lesion, a disturbance of normal structure.

[3] Relative to the sensations of movement.

[4] Relating to the skin.

Interesting as the knowledge of such physiological discoveries is for psychology, this interest is comparable to that of being able to translate the knowledge obtained in one language into another language. The two languages must be regarded as distinct; their relation is uncertain; they do not, of necessity, "think" identically; they must therefore never be confused with one another. Yet at any time the knowledge learnt through the one language may be helpful to that learnt through the other, which runs to a certain, but unknown, extent parallel with it. No psychologist can read of the brilliant investigations of Sherrington on reflex action without appreciating their suggestiveness in regard to the course and characters of the higher mental processes in which he is himself concerned. Some day, we may hope, the researches on the behaviour of the intact human and animal organism, which, owing perhaps to their complexity, have been neglected by the physiologist and zoologist and studied almost solely by the psychologist, may be correlated with physiological structure; but the interests of the psychologist and the physiologist must always remain different, the former relating behaviour to *mental* structure, the latter relating it to *bodily* structure.

The day is far distant when consciousness will be correlated with changes in living matter; and, indeed, conceivably it may never arrive. Whether it can arrive or not, psychology will always claim a position of independence, interested, it is true, in the physiology of the nervous system, but closely relating itself to medicine, education, industry, and art, to the study of human institutions and beliefs, and indeed of all processes and products of mental life, in a manner and with an outlook quite distinct from the methods and the standpoint of physiology. The time has come, I submit, when a separate Section of this Association should be devoted to Psychology, grateful though this subject must always remain to the hospitality which Physiology has always offered her, and to the help she has received from Physiology in her advance to the position of an independent Natural Science.

The People of Ancient Rome

By Joshua Whatmough, M.A.

Faulkner Fellow of the University of Manchester

"There hath been in Rome strange insurrections: the people against the senators, patricians, and nobles."

SHAKESPEARE, *Coriolanus.*

MODERN forms of law and government and the names used to describe them are largely derived from those of ancient Rome; yet the two words *patrician* and *plebeian*, which denoted the two classes into which the Roman people was sharply divided for five centuries and more, though they have been taken over into modern languages—our own, for example—have not retained any political significance. In ancient Rome they were highly political, but they marked something very different from our system of party politics, and in modern English, as well as in French and Italian, the words suggest distinctions which are social, not political. Still, the words are significant enough, and some account, in the light of recent research, of the two classes, the *patricii*, or "folk with fathers," and the *plebs*, or "multitude," in the ancient Roman state, may not be without interest for the general reader.

The Romans themselves, as we shall see, preserved a tradition concerning the nature of the distinction both in Italy generally and in Rome itself, but they could not point to any definite historical events with which they might connect it; for its primitive character had been altogether changed before they began to make the written records which we still possess. Mommsen, the famous German historian of Rome, made a pronouncement which was accepted without question, and may be found in nearly every textbook on Roman history published since he wrote—namely, that the distinction between the two classes was essentially one of wealth; that the Patricians were the old Latin burgesses and the Plebeians a collection of clients and dependents who had (for some reason not forthcoming) ceased to act with their patrons, together with some foreign settlers who had gathered around them. But the long and bitter struggle of the Plebeians for equality, and the mutual jealousy between the classes, especially in such matters as religion and intermarriage, bear marks which suggest at least that the distinction must have been of a more fundamental character.

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[1] Skin sensation is often supposed to be divisible into a more primitive type known as protopathic, and one more recently developed and more accurate which is known as epicritic.

[2] The cortex cerebri is the external layer of nerve cells of the "brain," or cerebral hemispheres. The nerve cells of the optic thalamus form connections with the cerebral hemispheres, the cerebellum, and lower levels of the central nervous system.

Amongst the Romans themselves there was a deeply rooted belief that the old Roman state had come about by the union of two separate communities—one an older settlement of Latins on the Palatine Mount, the other of invaders belonging to a race called Sabines, who in historical times occupied a tract of country to the east and north-east of Rome; this second settlement was associated by the later Romans with the Quirinal Hill. This tradition Mommsen denounced as an idle fiction, although more patient and philosophic historians like Schwegler had judged it on its merits to be substantially correct. What the modern reader has a right to ask is whether recent discovery has disclosed any new evidence which will enable us to accept the old tradition with confidence or to reject it with more solid reasons than Mommsen put forward.

Let us ask first whether anything can be said of the relation of these two classes or strata in the citizens of Rome to the peoples of ancient Italy generally. Most of us think of Latin as a language spoken throughout the length and breadth of the Italian peninsula; but for what date was this true? It was not until the beginning of the last century B.C. that the great mass of the inhabitants of Italy spoke Latin, and even then the local dialects were by no means extinct. They survived in rural districts for unofficial purposes until the first century A.D., and in small isolated spots possibly still later; and they have left their mark on some of the modern Italian dialects which in the main are derived from Latin.[1] But early Italy was peopled by a variety of races speaking a variety of dialects, amongst which the Latins and their language occupied a very small area. Of Latin we have, of course, abundant records; we have also sufficient remains of the other dialects in the form of inscriptions, glosses, that is, isolated words and phrases noted or explained by ancient grammarians, and also a considerable record of the names of places and persons from the dialect-areas. The evidence from all these sources has been carefully studied, and it has been shown beyond doubt that there were in Italy, at the time when Rome was founded, at least two strata of population speaking different though kindred tongues. Both these tongues belonged to the great family which is called Indo-European, from its including, on the one hand, the oldest languages of India—Sanskrit and the languages derived from it—and on the other nearly all the languages of ancient and modern Europe—Greek, Latin, Keltic, German, English, and the rest. The first, then, of these strata was occupying the west coast of Italy before the arrival of the Etruscan people. Who the Etruscans were is a puzzle still under study, but we know enough to be quite sure that they were not Indo-Europeans, and that they came from Asia Minor. The second stratum of population appears, in the west and south at all events, later than the Etruscans. Now it is to these two strata that we may now respectively attribute (1) the Latins represented at Rome by the Plebeians, and (2) the Sabines represented by the Patricians. It is clear, further, that before the arrival of the Etruscans, still longer before the invasion of the northern race to which the Sabines belonged, the main element of the population of the peninsula was identical with the earlier stratum. But the invading race of "Safines" which came down from the north gradually worked its way southwards, entrenching itself in the mountain-valleys from which it made raids upon the more fertile coast-lands. The hardy Samnite race which, four centuries after Rome was founded, came into conflict with the Romans and made such a long and brave fight against them were of this same Safine stock; so that the greatest struggle which the Roman commanders, who were mostly Patricians, ever conducted was really against their own cousins, separated from them by geographical accidents. The swarms which these Safines had sent out from the mountainous centre of Italy had subdued almost the whole of the south by the fourth century B.C.; and some of the more enterprising had even crossed into Sicily and settled in Messina. Thus the earlier folk of Campania, called the Osci, had been conquered by the Samnites, and by 400 B.C. had learnt to speak their language. Farther north, many tribes of Central Italy, such as the Marsi and Sabini, were also branches of the invading race.

But the reader may reasonably ask how these conclusions, stated here so briefly, have been reached. By what criterion can a given tribe be assigned to the one or the other race? Where enough linguistic evidence has been preserved upon inscriptions—the best of all records—the task is comparatively simple. Between Latin, the language of the earlier population at Rome, and Osco-Umbrian, as the language of the other group is called, there are clearly marked differences. The most striking is the treatment of one class of the original Indo-European consonants, those technically known as the "velar plosives" (like English *qu* in "queen" and *gw* in "Gwatkin"). In Latin these sounds were in general preserved, with a following *w*-sound; in the Osco-Umbrian dialects they became labials, *p* and *b*. For example, Latin *quis*, "anyone," corresponds to Oscan *pis*; so also Latin *quanta*, "how large," to Umbrian *panta*; Latin *quinque*, "five," to Osco-Umbrian *pompe*. The same difference separates the two subdivisions of the Keltic group of languages (Irish *cōic*, but Welsh *pump*, "five"). This separation of the dialects into *p*-dialects and *q*-dialects on the basis of the classification just described is excellent so far as it goes; but it fails us in those cases where the records are too scanty to give us even a single certain example of *p* or *qu* arising from an original *q*. In these cases we have to seek other evidence of the character of the language of the people into whose antecedents we are trying to inquire.

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[1] For example, just as beside pure Latin *ruber*, "red," there was the dialect form *rufus*, we find Latin *bubulcus*, "ploughman," but from a dialect form with *-f-* modern Italian *bifolco*; similarly Latin *scarabæus*, "beetle," modern Italian *scarafaggio*; Latin *tabanus*, "horse-fly," modern Italian *tafano*. Note that these are words of the country. Again, *-nd-* in Latin corresponds to *-nn-* in the dialects, a peculiarity well known to Plautus and reflected in modern South Italian dialects. Compare dial. *unnici*, "eleven," with Italian (Tuscan) *undici*, Latin *undecim*.

Now it has been very acutely observed that the ethnical or tribal names of the two strata of population are marked by the use of particular suffixes. The names of tribes which were members of, or had been absorbed by, the incoming northern people are distinguished by the suffix -NO- (nom. pl. *-ni*) as *Sabi-ni*, *Luca-ni*, *Hirpi-ni*, *Roma-ni*, *Campa-ni*, *Iguvi-ni*, and many others. This suffix is found all over Italy, at all events the peninsular part of it; but its frequency varies considerably in different districts. Amongst the Hirpini it is by far the most frequent; in Campania, Lucania, Latium, and amongst the Sabines it is preponderant, whereas in Umbria it is less common than its rivals. The earlier stratum, on the other hand, is to be connected with the suffixes -CO- and -(A)TI-, for example, *Falis-ci*, *Aurun-ci*, *Marru-ci* (*totai maroucai*, "for the Marrucan people," on an inscription of the fourth century B.C.) and *Ardea-tes* (the people of Ardea), *Tibur-tes* (the people of Tibur, the modern Tivoli), and neuter words like *Rea-te* or *Prænes-te*, and in Rome itself *Quiri-tes*. Both of these suffixes also appear amongst the peoples of Northern Italy, where the population is known from archæological evidence to have been closely related to the early inhabitants of Latium. It is to be observed, further, that this group of names, which appears in greatest frequency on the west coast and in the centre of Italy, often suffered a later extension by the addition of the -NO- suffix, as the peoples bearing them gradually came under the dominion of the Romans (Roma-ni) or, earlier, of the Samnites (who called themselves *Safi-ni*, "Safines"). Thus the *Marru-ci* became *Marru-ci-ni*; the people of Ardea are no longer *Ardea-tes*, but *Ardea-ti-ni*, and of Ari-ci-a *Ari-ci-ni*. In Teate, in Apulia, -TI- gave place altogether to -NO- and Teate became *Tea-num*.[1] The same process is extended even to non-Italic communities, and the citizens of Naples, who in Greek called themselves *Neapolitæ*, were called by the Romans *Neapolitani*. The old ethnicon of the people of Latium, *Latiaris* (as in *Latiaris collis*) is dropped for *Latini* after the Sabines have made themselves masters of the land, just as in Rome itself we have *Quiri-tes* and *Roma-nus* in the phrase *populus Romanus Quiritium*. The reverse process, too, may be seen at work in a case like that of Iguvium in Umbria, whose people called themselves first *Iguvi-ni* and then *Iguvin-ates*, presumably because the -NO- invaders had been at some time replaced in authority by a *risorgimento*, as it would be called in modern Italy, of the people they had once conquered.

In a few places in Italy, such as Bologna, where archæological deposits are found one above another in layers representing successive epochs of time from the early Bronze Age down to the Roman period, after the remains of the Roman, Gallic, and Etruscan strata have been removed, there are found two strata which have been recognised as respectively the remains of the two stocks of population we have been discussing. Though there are many things which still remain obscure from the archæological standpoint, this much may be taken as certain, that the lower[2] of these layers represents the Bronze and preceding Ages, the upper the Early Iron Age. It is clear, too, that the northern invading race brought into Italy the use of iron, and that in the north of Italy they were on the soil before the Etruscans. Thus in the lowest deposit we find that cutting implements are all made of stone or bronze, while iron is unknown; in the next stratum above it weapons made of iron, axe-heads and the like, are beginning to appear with considerable frequency. Above this comes the Etruscan stratum, then the Gallic, then the Roman.

We must now return to Rome. Livy relates with grave humour the famous and popular legend how King Romulus obtained Sabine women as wives for his men by inviting a host of Sabines with their families to a royal festival; how war between the Romans and the Sabines followed when the Romans carried off the Sabine maidens to be their wives, and how at last the women rushed in to make peace and union between the two peoples; Livy records how, further, Romulus was succeeded by Numa Pompilius, the Sabine. The Sabines were believed to have occupied the Quirinal Hill, whose name was derived from that of the Sabine god Quirinus. This legend is typical of a series of the same character which show how strongly the Romans held to the tradition of the composite nature of their population. But, apart from such traditions, we find institutions surviving in ancient Rome which help us to explain the tradition, and which connect the ruling class of the Patricians with the Sabines. A number of Sabine words deeply embedded in the Latin language itself lend us further rather striking support.

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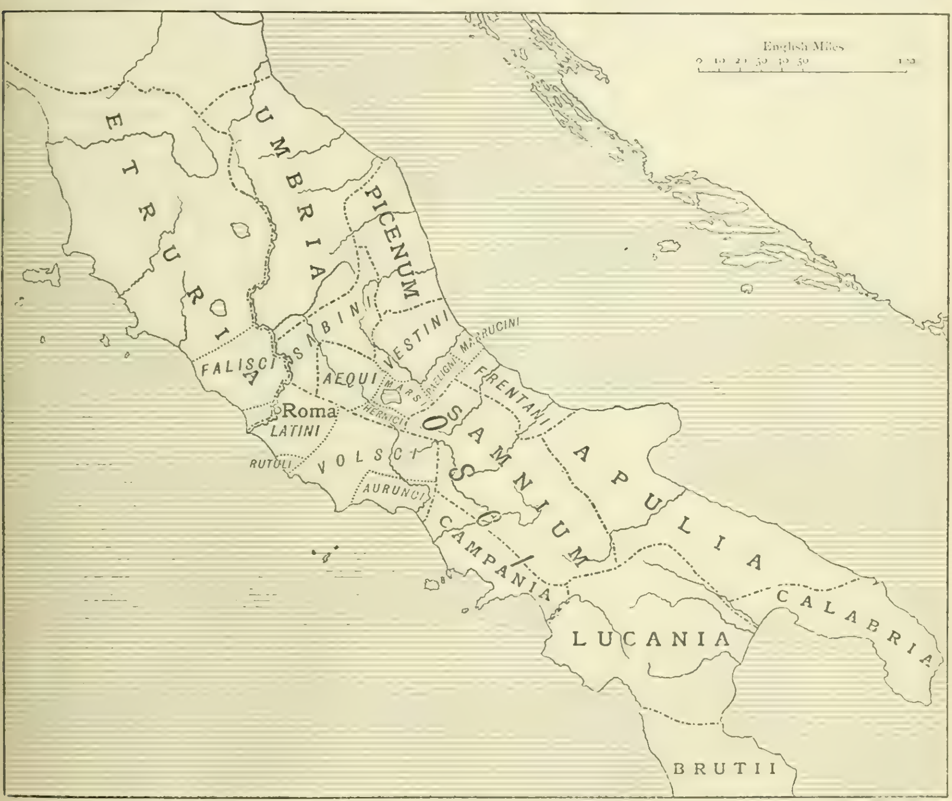
[1] Livy, not knowing this, actually in one place relates the same event twice over in the same chapter (ix. 20), because some of his authorities spoke of *Teates* (§ 7), the others of *Teanenses* (§ 4). R. S. C.

[2] Contemporaneous with the lake-dwellings and *terremare* described by Professor Halliday in the August number of DISCOVERY, pp. 236 ff., and characterised by objects mostly of the *terramara* types, although at Bologna not an actual *terramara*, but a group of hut-villages, has been found. The significance of the different form of dwelling is not clear.



THE PEOPLES OF ANCIENT ITALY.

Amongst the Roman gods there were at least three —Mars, Ianus, and Quirinus—which were of Sabine origin. Mars among the Sabines was a god of war; Quirinus was connected with the Sabine town of Cures; and the worship of Ianus was introduced at Rome by the Sabine king Numa Pompilius; so every Roman believed. Now the three priests who attended upon these three deities, the priests of Mars, Ianus, and Quirinus, were called by the ancient name of *Flamen*, which has been attractively identified with the Hindoo name for a member of the great priestly caste, *Brahman*. All three together were called the "greater priests" (*flamines maiores*), and had to be Patricians and the children of Patricians married in the proper Patrician usage, in distinction from the three "minor priests" (*flamines minores*, of certain other deities) who had to be Plebeians. This shows that the deities of the

Patricians were the deities of the Sabines; and this can mean nothing less than that the Patricians were Sabines. Further, one of the two old Roman calendars—which were essentially religious documents—that known to the Romans as the Calendar of Numa, began with the month of the Sabine god Mars—*mensis Martius*, or March. This calendar the Patricians for many centuries (till 302 B.C.) succeeded in keeping strictly secret, and in their own control. And we shall see that one of the festivals recorded in it actually had its name in a Sabine, non-Latin form.

At Rome there were three forms of marriage. The first, called *confarreatio*, "meating together" (to use "meat" in its etymological sense), was accompanied by a solemn religious ceremony, and was entirely different from the other two, which were known as *coemptio* and *usus*. *Coemptio* involved a civil ceremony which was a survival of wife-purchase; marriage by *usus* was brought about by nothing more than cohabitation for the period of one year. It is clear that *confarreatio* was the Patrician form of marriage, because no one could be one of the *flamines maiores* unless his parents were Patricians who had been married by it; but this rule did not apply to candidates for the "minor" priesthoods. The barrier, too, against intermarriage between Patricians and Plebeians, which was not broken down until so late as 445 B.C., suggests a distinction in form of marriage as well as in the way it was regarded. For *confarreatio* was held to be a binding contract from which there was no divorce (save with great difficulty); whereas to be released from marriages entered into by means of *coemptio* or *usus* was as easy as to contract them. In this we find reflected exactly the moral and social conceptions of the two strata of population. The Sabines remained, down to Imperial times, patterns of virtuous living held up for imitation to the degenerates of those days. There is, on the other hand, good evidence [1] that the peoples of the earlier stratum had at one time, and that a time not wholly forgotten, traced descent through the mother only. This custom, as students of anthropology know, descends from an epoch when marriage, fatherhood, and family life as we understand it had not been developed. We should therefore expect their views of married life to differ from those held by the Sabines, whose racial connections are with northern peoples of severer moral standards.

It is universally admitted that the military constitution attributed to Servius Tullius, the sixth of the "seven" kings, must in its main outlines be taken as historical. Under this all citizens were divided into five classes according to their wealth, and their armour and place in battle varied in the same way. Now the first of these five seems before Tullius to have constituted the entire (Patrician) army alone, and the arms which it bore are analogous to those used in Central Europe by the warriors of the Early Iron Age. The most conspicuous example is the round shield, which was also carried by the *Equites*, or Cavalry, always linked with the First Class. But the armour of the other classes was incomplete, and the shield they carried was the oblong one; and this was the type of shield used generally by the Mediterranean peoples of the preceding age. In this again, therefore, we have evidence that the ruling class at Rome was an invading body which came from the north, bringing with it its own type of armour.

Now turn again to the evidence from language. We have already seen that Latin, the language spoken by the Romans, was a *q*-language. For Sabine, the evidence we have makes it probable that it was a *p*-language. Thus the name of the king *Numa Pompilius*, whose birthplace given by tradition is the Sabine town of Cures, would in Latin be represented by *Quintilius* (standing for *Quin(c)tilius*). But Numa, it is needless to say, was a Patrician.[2] The common names, *Pompeius*, *Petronius*, and some others must have been borrowed, like *bos*, "ox," from some of the *p*-languages, the nearest of which to Rome was Sabine. If there was a considerable Sabine element in the population of Rome, it is easy to see how this and other borrowings came about. Particularly interesting is the name of a district in Rome which in early times we know was called *Sugusa*, and which therefore, in Latin of the classical period, we should expect to appear as *Sugura*, whereas we have instead the familiar *Subura*.

In Latin, what are known as the Indo-European palatal and dental aspirates (*gh* and *dh*) became *h*- initially, but in Sabine they became *f*-. Yet in Latin we have words beginning with *f*- which we know, from comparison with other languages, began with *gh*- or *dh*- in Indo-European. These can only have been borrowed from Sabine. They include *filum*, "thread"—spinning was the mark of the Patrician and Sabine ladies[3]; and two words which are of special interest, *fer-ru-m*, "iron," literally "the hard substance," that is "iron ore"; compare Marsian *her-na*, "stone," for, as we have seen, there is good reason to believe that the northern race brought the use of iron into Italy; and *fordicidia*, the name of a festival—on April 15—marked in the Sabine Calendar of Numa, pure Latin *hordicidia*.[1]

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[1] Note especially what Vergil says about the Latin senator Drances in *Æneid*, xi. 340–41:

"Genus huic materna superbum
Nobilitas dabat, incertum de patre ferebat."

("His mother's noble birth gave him high rank; none knew surely the race he inherited from his sire.")

[2] The initial of *Quirinus*, the Sabine god attended by priests of Patrician extraction, who gave his name to the Quirinal Hill where the Sabine settlement had been made, seems an exception. But there is reason for thinking that it is derived from Cures, and should be *Curinus*, but was altered to Quirinus in order to coincide with the name of the citizens of Rome, the *Quirites*.

[3] The pure Latin *hilum* survives in *ni-hil*, "nothing," literally "not a thread." The explanation of *ferrum* as Sabine is due to Professor Conway, who allows me to publish it here for the first time.

Yet another interesting case is the change of Indo-European *d-* to *l-* in Sabine, although it remained unchanged in Latin. The stream which flowed past Horace's Sabine farm is naturally called by him by the name it had over its lower course in Latin territory, the *Digentia*; but by the Sabines, who lived nearer its source, it must have been called *Ligentia*, since its name on the spot is still at this day *Licenza*. *Odor* is the polite Latin word for "scent, fragrance," formed (like *splendor* from *splendēre*) from a verb *odēre*; but this Latin verb was at some time displaced by the Sabine form *olēre*, used by farmers, and referring to farmyard smells.

Enough has been said to show that Latin differed considerably from Sabine. The Latin language, therefore, must have been the language of the conquered Plebeians, not of the conquering Patricians. It was always called the *lingua Latina*; yet the people who spoke it was the *populus Romanus*, more fully, as we have seen, the *populus Romanus Quiritium*, a description which embraces the old and the new elements in the population.

One of the districts of Rome, the *uicus Ciprius*, or *Cyprius*, derived its name from the Sabine word for "good." And the haughty Patrician family of the Claudii were descended from a Sabine who, as we read in Livy, on his migration to Rome was welcomed by the Patricians in a way which shows that they must have been in the main Sabine themselves.

On many sides, therefore, we have excellent reasons for believing the tradition of a Sabine settlement at Rome, and further for identifying the Sabines there with the Patricians. We may surely go further, and see in the incorporation of this hardy stock, with its strict way of life, one of the strongest factors which made Rome the mistress of the world:

> "Hanc olim ueteres uitam coluere Sabini,
> . . . sic fortis Etruria creuit,
> Scilicet et rerum facta est pulcherrima Roma
> Septemque una sibi muro circumdedit arces."

("This was the life led by the Sabines of old . . . so Etruria grew bold, and Rome with her seven citadels

[Continued on p. 346

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[1] I hope shortly to publish elsewhere a note on the etymology of this word.

MR. HEINEMANN'S LIST

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HEINEMANN

surrounded by one wall became of all things on earth the most glorious.")

BIBLIOGRAPHICAL NOTE.—The results of recent research indicated in this article have not yet found their way into the ordinary textbooks on Roman history. The reader will find further details in an interesting and easily accessible form in the valuable articles on the peoples and languages of ancient Italy by Professor R. S. Conway, in the last edition (the 11th, Cambridge, 1910–11) of the *Encyclopædia Britannica.* A start should be made with the articles (i) Italy, History, A: *Ancient Languages and Peoples* (vol. xv, p. 25); (ii) Sabini (vol. xxiii); and (iii) Rome, Ancient History, I: *The Beginnings of Rome and the Monarchy* (vol. xxiii, p. 615); references are given there to some other articles by the same writer in the *Encyclopædia,* and also to other works, of which the most useful and compact (although somewhat controversial) is Professor Sir William Ridgeway's paper, *Who were the Romans?* (1907) published in the *Proceedings of the British Academy,* vol. iii (1907–8), and also separately by the Oxford University Press. (The present article is based on the published works and teaching of these two distinguished scholars, and the writer takes this opportunity of acknowledging his deep obligations to them, especially to Professor Conway, who read the whole of this article in manuscript. In its final form it owes not a little to his numerous suggestions.) A German writer, Binder, has since followed in support of the same view in his book *Die Plebs* (1909). The problems of early Italic ethnology were discussed in relation to the primitive peoples of the Mediterranean lands and their civilisation in Professor Ridgeway's *Early Age of Greece,* vol. i (1901, Cambridge University Press). There is a succinct and popular account of the Indo-European peoples, with special reference to Greece and Italy, in the second of two *Lectures on the Science of Language,* by the late Professor J. H. Moulton (1903, Cambridge University Press). For a full statement of the early archæological evidence revealed by excavation see Professor T. E. Peet's *Stone and Bronze Ages in Italy and Sicily* (1909, Clarendon Press).

The Potato

By George C. Gough, A.R.C.Sc., B.Sc.

IF there was one thing more than another that the war taught the Englishman, it was the value of the potato as food. Like many another common thing, it took a great war to make him appreciate its worth, and the scarcity of the tuber in the winter of 1916–17 brought home, both to rich and poor, more especially the latter, the fact that it was an essential article of his diet.

Although not a perfect food, the value of the potato for feeding purposes has now been recognised by the nation, and when the submarine campaign was at its height, great efforts were made to increase the acreage devoted to this crop, as it has the advantage of yielding more food per acre than any other crop, excepting, perhaps, the sugar-beet, which largely loses its advantage by having to go through a manufacturing process before being fit for human consumption.

The early history of the potato and its arrival in England is given in most encyclopædias, but the tale of Sir Walter Raleigh's gardener, to whom he gave it as a fine fruit from America, is not so well known. The gardener was desired to plant it in the spring; in August the plants flowered, and in September produced fruit which, in rather an ill humour, he carried to his master. "Is this the fine fruit from America you prized so highly?" he asked, as he showed the potato apple. Sir Walter pretended to be ignorant of the matter, and said that, "Since that is the case, dig up the weed and throw it away." The gardener, however, soon brought back a parcel of potatoes.

It is very probable that the early potatoes gave poor crops, but many flowers and fruits, or potato apples as they are called. Since that time, owing to selection and cross-fertilisation, the crops have increased very greatly, and although a few varieties which flower and fruit freely give good crops, as a whole potatoes flower but little nowadays.

From a theoretical point of view this is an advantage, as a plant cannot produce a good crop of tubers as well as seed. The ordinary seed potato is not true seed, being merely a tuber of a suitable size riddled out of the crop. The tuber is not a root, as so many people think, but it is a modified underground stem and bears leaves; albeit these are very small and scale-like, so that their general appearance is seen as an eyebrow above the "eye" of the potato, which in its turn is a bud.

The tuber is but a store which contains the surplus food material manufactured by the leaves, and anything that will enable the leaves to remain green longer than they otherwise would do enables the plant to manufacture more food, and therfore to give a better crop of tubers. This food is manufactured by the leaves during the day-time in the form of sugar, which is almost immediately converted into starch, but during the night, by means of secretion called a ferment or enzyme, it is reconverted into sugar, taken down the stem to the tuber, and there stored again as starch, as only soluble materials can be transferred through the plant.

When the tuber commences to grow, this starch is again converted into sugar, and used by the young plant until it has produced sufficient roots and leaves to start life on its own.

The hard seed tubers one frequently finds, when a potato plant is dug up, seem to be due to the fact that sufficient enzyme was not present in order to convert the starch into sugar.

The presence of this hard tuber is often associated with the presence of a disease called leaf-roll, of which little is known, but which causes a great reduction of crop. Such tubers germinate but slowly, and produce few and weak shoots under ordinary conditions. Should they, however, be placed in a warm greenhouse for a few days, apparently the enzyme is developed and growth will proceed more or less normally when "seed" is planted.

The potato crop has been greatly increased in recent years by selection of varieties and also by producing new varieties by crossing. The hybridist takes two varieties which have the characteristics which he requires, and after duly preparing the flower of the one by removing the pollen bearers, or anthers, he places the pollen from the other plant on the female portion of the plant which is to bear the seed. If successful—and it is but a small percentage which are—true seed is formed in the potato apple or fruit. After suitable treatment, this seed is sown, usually in a greenhouse, the following spring, and when the new plants are large enough, and weather is suitable, they are planted out.

Only few and small tubers are formed the first year, and the tubers are used as "seed" the following two or three years until a stock of the new variety is obtained, and its characteristics are manifested. Should it prove different and superior to varieties already in commerce, the raiser takes steps, either himself or by selling it to a firm who will do it, to increase the stock, and every effort is made to get as many plants as possible from the few "seed" tubers available. This is done by using up the eyes to produce plants, and also by taking cuttings and striking them under glass, so that a large number of plants are available for growing out-of-doors to produce a further stock of tubers.

Many of the varieties now in commerce have been produced this way, with the exception that, while the female plant is known, the male plant can only be guessed at, owing to the fact that many of the raisers used mixed pollen which had been obtained from various varieties, and no one knows which variety produced the pollen grain which successfully fertilised the ovule (egg cell) of the female.

Another curious note in connection with the production of new potatoes is that a seed ball will produce seed which will give rise to plants which are quite distinct from each other, and different varieties have been raised from the same potato apple. Nowadays, when the potato raiser has a new variety, he usually sends it to the potato-testing station at Ormskirk in order to find out if it is immune to wart disease (see June number of this Journal, p. 179). Before a potato is placed on the market, the raiser has to see that it has characteristics which commend itself to purchasers, as the public has very decided tastes in the matter of a potato. Thus the public will not have a coloured potato, and farmers who have grown such will not be able to sell their produce except at well under

[*Continued on p.* 348

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the market price, although such potatoes may boil quite white and be of good flavour. An exception to this at the present day is the fact that King Edward, a kidney variety with pink patches around the eyes, is probably the most popular potato, but it was not for several years that the public took to it, and the early growers of this variety had great difficulty in disposing of it. It is curious that in the eighteenth century red varieties were more common in England. Philip Miller, in his *Dictionary of Gardening*, 1731, says: "Red and white potatoes are both indifferently cultivated in England, though the red sort is most commonly brought to the markets."

A potato should also be of good shape and have shallow eyes, or it is wasteful in peeling. A kidney or oval shape is usually preferred, but in many districts a round shape is liked. Although there are exceptions, a general rule is that a round potato does better than a kidney potato in heavy soils.

Potatoes grown in England, and especially in the South, soon degenerate or "run out," as it is called. Seed tubers saved from plants grown in the South thus produce a large proportion of the hard tubers already mentioned, with consequent decrease in crop. Much of this loss, however, would be obviated if proper selection were made of the plants when growing, and if these were lifted before the haulms had died down. In many foreign countries the same degeneration takes place normally, but by careful selection of plants, and by planting "seed" on a different kind of soil from that on which it was grown, the crop tends to increase rather than decrease. In England the farmer, if he selects at all, just takes the tubers of medium size and of good appearance for seed; and as plants suffering from leaf-roll produce tubers of good appearance and of seed size, these are frequently selected, to the detriment of the future crop. The cause of this degeneration is not quite certain, but it seems to have something to do with the ripening of the tuber, as if such potatoes are lifted quite early while the haulms[1] (stem and leaves) are still green, the resulting seed gives good crops. The aim of the English farmer is to get Scotch "seed," as he usually finds this gives him a better crop than "seed" grown in England, and the generally accepted reason is that "seed" grown in Scotland does not properly mature. There is reason to believe that the average rainfall also has its effect, as "seed" from the west coast of Scotland gives the best results.

The average crop in England is less than six tons to the acre, being as low as four or even less on poor, heavy soils. On the other hand, it may be as high as sixteen tons in Lincolnshire and the Fen District of Cambridgeshire, when the crop is grown under the best farming conditions. On the whole ten tons may be considered as a good ordinary farm crop, but a private gardener or good allotment-holder may readily get a crop which works out at twenty tons to the acre. For market a crop may be harvested either by digging with forks, or by a machine which by a rotary motion drives the potatoes out of the ridges so that they can be picked up by women and children. They are then carted to the place where they are stored, usually near the gate of the field. Here a long shallow trench is dug and lined with straw. Into this the potatoes are tipped and piled as high as they will go. They are then covered with dry materials (straw, bracken, etc.) and allowed to dry off for a few weeks, when they are covered with earth to keep out rain, frost, etc., holes plugged with straw being left for ventilation. Such structures are called hogs, clamps, pits, buries, etc., according to locality. The potatoes are gradually marketed, being passed over riddles to take out the small potatoes, leaving the larger ones, or "ware," for market, the smaller ones ("chats") going through and being fed to animals. In the North and in Scotland another riddle is used between the ware and the chats, and by this means "seed" is obtained.

Another point that potato growers are beginning to realise is that quantity is not everything. A recent paper[2] issued as a Royal Society's report shows that certain potatoes have a much greater value as food than others, and it is quite possible that, although a farmer may get a lesser crop with certain varieties, he may yet get more feeding value to the acre. Such potatoes have usually the reputation for being of good cooking quality.

This point is interesting when considered in connection with the recent work done in Denmark[3] on the feeding value of turnips and mangels. Here it is found that certain strains of a variety are of much greater food value than other strains, and nowadays the best seed merchants there guarantee that the strain they send out is of a particular food value, and will pay damages if the crop is not as guaranteed, the State's Seed Testing Station being the assessor.

The potato is now, therefore, coming to its own. In America it has its own magazine, and in England the new National Institute of Agricultural Botany has obtained a station in Lancashire where further research on it can be carried out.

The Germans have for many years recognised its value not only as a food, but also for industrial purposes generally, and large areas are devoted every year to the production of this crop, while research stations all over the country spend a good deal of time in its improvement.

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[1] "Shaws" in Scotland.

[2] Food (War) Committee Royal Society, Report on Composition of Potatoes, April 1920

[3] *Forage Crops in Denmark*, by Harald Faber. (Longmans, Green & Co., 1920.)

[There are many books on the Potato, but nearly all are small handbooks on its cultivation. Up-to-date information should be sought in the Journals of the Royal Agricultural Society, the Royal Horticultural Society, and of the different Boards of Agriculture.]

Correspondence

POTATOES FROM SEEDS

To the Editor of DISCOVERY

SIR,

Miss Graham's article on *Potatoes from Seeds* is most interesting, but I should not like your readers to think—as so many people, led by seedsmen's advertisements, are thinking—that they can grow most varieties of potatoes from seed. It is the easiest thing in the world, if one is even an average gardener, to grow potatoes from seed; the point is that it is normally a waste of time and money.

Seed as usually supplied is from naturally-found seed balls and, except for a very few varieties which seed very freely, are rare. Hence it is from such free-seeding varieties that nurserymen obtain their stock of seed. The net result is that to a great extent "like produces like," and after several years' growing, a crop is obtained which is exactly like the original parent, and which could have been got in the first year from one "set" or seed tuber. Certainly a mixture of tubers often appears, but these are usually a "hark-back" to some ancestor which has gone out of existence owing to its having been ousted by more valuable varieties.

It is by no means a new idea to raise potatoes from seed. This has been done by specialists for years now, and it is only rarely that they get a new variety, and but a minor percentage of these are an improvement on existing varieties; this, too, when they have had the advantage of specially fertilising the flower with the pollen from another variety.

Another point to be remembered is that, if an attempt is made to raise a new variety in the southern half of England, if not elsewhere in the country, the seedlings will lack stamina and will not give good results, as I have explained in my paper.

The potato world just now is suffering from a plethora of names. Seedlings are raised and put on the market as new, and yet they have all the characteristics of an old variety. Thus the well-known potato "Up-to-date" is at present masquerading under some 150 names.

To sum up—raising potatoes from seed is a pleasant hobby, but if it is to be of any value, long study and experience will be necessary.

GEO. C. GOUGH.

44 HAZLEWELL ROAD,
PUTNEY, S.W.15.
October 7, 1920.

[*Continued on p.* 350

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DRAKE

To the Editor of DISCOVERY

SIR,

With reference to Mr. Geoffrey Callender's article as to whether Drake could be justly accused of murder or not, I would like to state that, according to documentary evidence of his Portuguese pilot, Nuña da Silva, discovered in Mexican Archives by Mrs. Nuttall, Drake, when challenged by Thomas Doughty to show his authority empowering him to order the execution of his friend, produced some papers and handed them round for inspection.

It would appear to be a difficult task to acquit Drake of the charge of murder merely on the assumption that there are no incontrovertible facts to show that he possessed the very necessary delegation of authority from Elizabeth, and one would be perfectly justified in assuming such papers to be false, inasmuch as he did not originally sail from Plymouth for the purpose of getting a cargo of currants from Egypt, but, in reality, to visit once more the West Indies to obtain vengeance for his old shipmates who had been murdered.

Until such evidence is forthcoming to prove the above-mentioned papers to be absolutely in order, it is rather premature to ask the public as a grand jury to acquit him of the charge of murder, although it originated from obscure Spanish sources.

I should be glad if you would inform me whether there is in existence, to this date, evidence to show that the authority that Drake claimed as legal *was* legal.

VICTOR H. STANDFORD.

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Reviews of Books

The Memorial Book of William Sutherland. A Biography. By PROF. W. A. OSBORNE. (Lothian Book Publishing Co., Melbourne, 7*s.* 6*d.* net.)

The little book before us, beautifully printed and neatly bound, is a tribute from Australian friends to a Melbourne scientist who lived a happy life.

William Sutherland (1859–1911) was a Dumbarton boy who, when very young, went with his parents to live in Melbourne. After taking a good degree in science at the University there, he sailed for London, took another one, returned and settled down in Melbourne for good. The rest of his life was calm, peaceful, happy. He lived at home, he never married; nothing excited or worried him. He had no regular job except the thing he lived for—the advancement of scientific knowledge. Everything was subordinated to that. He worked on physical problems wholly from the theoretical point of view. I mean he worked with pen and paper in his room at home, not in a laboratory at the works or at a University. His financial needs were never great, and these he satisfied by doing examining for Melbourne University and by occasional coaching; but this kind of thing was looked upon merely as a necessary evil to keep the pot boiling, and resorted to solely when the pot or the fire required attention.

To Sutherland, Science was a much bigger thing and the things of this world were much smaller things than they are to most of us. He sold all he had and gave it and himself to Science. During his lifetime he published no less than sixty-nine papers; most of these deal with molecular physics, and most were published in the *Philosophical Magazine.* His work really was of importance, but he was not a genius. He was too happy a man to be that. But it is a pity he did not collect his work in book form and bring it more prominently before the world. A little advertising might have helped him greatly. Melbourne is a long way off from London, and an occasional blast on the horn would not have deafened anybody. But he never did this, and he was averse to popularising science.

His work was often very theoretical, and too technical, on the whole, to be described here. His chief success was the working out in 1893 of a relation connecting the viscosity of a gas and the temperature, which has been amply confirmed by subsequent work. But he had large and generous ideas on a great number of problems—the law of attraction between molecules, the nature of emulsions, and the application of electro-chemical ideas to the properties of matter.

Yet with due deference to Sutherland and his point of view, I think this quiet, home-keeping, apparently unworldly life of his was hardly the fullest. He seems to have had an aversion to taking up the work of a University teacher. He hated drudgery. But that is hardly a valid reason for avoiding it. A University would have given him a bigger stimulus; it would have given him a laboratory, led him into experimental work, brought co-workers to him. Probably he would not have been so happy, but happiness is not the only thing. I think his lack of experience in experimental research was a serious one. It is hardly a man's job working up and theorising on the experimental work of others. But there is room for difference of opinion here. Early in life he found the bent of his inclinations and abilities, and this he tried to follow out with his whole soul. That is a very great deal. He was an interesting and original man, quiet, hard-working, many-sided, perhaps a little, at times, "agin' the government." His outlook on life was something like Thoreau's.

I am glad this book has been written.

A. S. R.

(*Continued from p.* 334)

G. Pellissier, *Le Réalisme du Romantisme.* Paris, 1912.
G. A. Borgese, *Storia della critica romantica in Italia.* 2nd edition. Naples, 1920.
N. Busetto, *Il Romanticismo e il carattere nazionale della letteratura italiana.* Campobasso, 1919.
G. Martegiani, *Il Romanticismo italiano non esiste.* Florence, 1908.
O. Ewald, *Die Probleme der Romantik als Grundfragen der Gegenwart.* Berlin, 1905.
M. Joachimi, *Die Weltanschauung der Romantik.* Jena, 1905.
E. Kircher, *Philosophie der Romantik.* Jena, 1906.
O. Walzel, *Deutsche Romantik.* 4th edition. Leipzig, 1916.

Other Books Received

Science

Matter and Motion. By the late J. Clerk Maxwell, LL.D., F.R.S. Reprinted, with Notes and Appendix by Sir Joseph Larmor, F.R.S., M.P. (S.P.C.K., 6*s.*)

An Outline of Physics. By. L. Southerns, M.A., B.Sc. (Methuen, 6*s.*)

The Laws of Mechanics. By S. H. Stelfox, B.Sc., A.M.Inst.C.E. (Methuen, 6*s.* net.)

The Principles of the Phase Theory. Heterogeneous equilibria between salts and their aqueous solutions. By Douglas A. Clibbens, Ph.D. (Macmillan, 25*s.*)

Easy Lessons in Einstein. By Edwin E. Slosson. (Routledge, 5*s.*)

From Newton to Einstein. By Benjamin Harrow, Ph.D. (Constable, 2*s.* 6*d.*)

The Memorial Book of William Sutherland. By Prof. W. A. Osborne. (Lothian Book Publishing Co., Melbourne, 7*s.* 6*d.*)

Zoology. A textbook for Colleges and Universities. By Prof. T. D. A. Cockerell. (Harrap, 10*s.* 6*d.* net.)

A Kinetic Theory of Gases and Liquids. By Prof. R. D. Kleeman, D.Sc. (Chapman & Hall and John Wiley, 16*s.* 6*d.*)

The Influence of Man on Animal Life in Scotland. A Study in Faunal Evolution. By James Ritchie, D.Sc. (Cambridge University Press, 28*s.*)

The Boy Electrician. By Alfred P. Morgan. (Harrap, 7*s.* 6*d.*)

Psychology

Mental Tests in the American Army. By Majors C. S. Yoakum and R. M. Yerkes. (Sidgwick & Jackson, 6*s.*)

The book on which Dr. Veazie based his article in the September issue.

Psycho-analysis. Its History, Theory, and Practice. By André Tridon. (Kegan Paul, 10*s.* 6*d.*)

Phenomena of Materialisation. By Baron von Schrenck-Notzing. Translated by E. E. Fournier d'Albe, D.Sc. (Kegan Paul, 35*s.*)

The Human Atmosphere (the Aura). By Dr. Walter J. Kilner. (Kegan Paul, 10*s.* 6*d.*)

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Editorial Notes

The continued success of Discovery has naturally attracted a number of suggestions for its improvement. Among the wants most strongly felt has been the need for fuller illustration, especially of the scientific articles. This is impossible without a change from the paper hitherto employed to one which will receive photographic reprints; and, of course, both this and the illustrations themselves will add much to the expense of production, which already, through the present rise in the cost of printing, has gravely exceeded the estimates. After careful consideration, the Committee has decided to provide more illustration, trusting that the generous support hitherto accorded to Discovery will not be diminished by the consequent increase in price stated above, which is more than justified by the increase in the cost of production.

* * * * *

With this number we complete the first year of our life. It has been an interesting year full of the surprises, adventures, and new beginnings that serve to make life, even at its worst, a much greater and finer thing than mere existence. In politics, in industry, and in the intellectual world, we are beginning to realise that the war is really over, and that hope and progress lie not in dwelling on the past, but in working in the present and planning for the future. This year has witnessed the first signs of resumed co-operation in intellectual work between ourselves and our late enemies; and although we must always respect and refrain from criticising the attitude of those who cannot see their way at present to resume the old friendly, co-operative spirit of the past, yet one may rejoice that many at least realise, and among them some who were not the least zealous in the fight, that the sooner we get back to the old attitude of mutual regard and understanding with those who wish it, the speedier will be the solution of those problems of science, of letters, and of life, on which the future of humanity so largely depends.

* * * * *

Two of the outstanding subjects of interest in the intellectual world have been the New Psychology and the theory of Relativity. Books, lectures, and discussions on these subjects have been popular everywhere, and when able men have lectured upon them, long queues of men and women have waited patiently for admission to the lecture-room. Aviation, in spite of the excellent and hopeful Air Conference in October, seems to have suffered a set-back. The climate, lack of generous endowment, and impatience seem to be contributory causes of this. A new star was discovered in the heavens in August. Mr. Wells's *Outline of History* has been completed and published, and the great biography of Disraeli commenced by W. F. Monypenny has been successfully finished by Mr. Buckle.

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These are but a few of the events of the year which concern us. Progress in all the chief departments into which intellectual matters in this country are divided seems good. It is sad to have to record that elsewhere things are different. Many eyes during the year have turned towards Vienna, a city that has for centuries been an outpost of light and learning towards the East, and which now seems to be falling into ruin and decay because of a lack of the necessities of life. What a splendid city was Vienna before the war! Brightness and mirth were in her streets. One remembers little things like the cream in the cups of coffee sold in her cafés, so thick that a lump of sugar carefully placed on top took fifteen seconds to sink into the coffee below. But the things that mattered: her University and institutes of learning, her men and women, all the beauty and the wonder and the power, then so high and great, and now—what a contrast!

* * * * *

It almost passes belief. We have been accustomed to see red when we think of Austria, and all the muck and misery into which the war she started has plunged us and herself: but when we reflect upon her present misery, the lack of an adequate supply of food, of clothing, and of fuel, which most of her inhabitants are experiencing; her students, professors, and investigators, famous in time past for their learning and their discoveries, now with barely enough, many of them, to keep body and soul together; without the means of buying books or of getting the necessary apparatus, *in some cases dying of starvation*; we feel that the advancement of learning is not yet so great and general a thing that the world without loss can let even one of its cities go down-hill. We rejoice that so many generous spirits have come forward with real offers of help and service, and we pray that they and others may have the power and means to save Vienna even yet from a fate which appears inevitable.

* * * * *

To turn to another matter.

There is a certain class of books against which, it seems to us, protest with some vigour should be directed, because we believe they are in their tone against the advancement of the subject with which they deal and of the esteem in which it is held, and in their facts ill-informed, misleading, and erroneous. The books we refer to are those in which a rough hash of truths, heresies, and misstatements concerning present-day science is used to set-off and make topical and interesting the theories and ideas of their authors upon the particular subject which interests them. No one minds very much—although, personally, we think people should mind a good deal more than they do—how wild and wonderful a man may be in his ideas and theories. They are interesting to somebody; interesting psychologically, for example, if in no other way. But when a book is published in which the patient work and ascertained results of investigators in such subjects as history, anthropology, biology, or chemistry are gently thrust aside merely because they interfere in some way with the particular bee in the author's bonnet, it seems high time for a protest to be made.

* * * * *

The book[1] before us, which we have selected to illustrate our point (which we hope is a sound one, and not just a bee in our own bonnet), is not a particularly bad example of the class, but that it could be written as it has been by a doctor, and published by an eminent firm of publishers in these difficult days, is, we think, an occasion for surprise. *The Origin and Evolution of Freemasonry* is a good subject, and this book deals, we are told, not only with freemasonry, but also with the history of the human race; it shows whence man originated, and how he progressed in evolution, and reveals how the various religious cults have been evolved. This sounds excellent. We are going to be told all about the origins of freemasonry, and we anticipate reference to, and résumés of, the work of Darwin, Sir J. G. Fraser, Edward Carpenter, and others. And so we commence the book at Chapter I.

* * * * *

But Chapter I gave us a shock—well, no, not a shock, but a surprise. At first we thought that by an accident another book had been bound in our cover, an idea which turned out to be wrong. The book did deal with freemasonry, but not in Chapter I. There was, secondly, the possibility that the book was a conscious skit on the subject. This view also we abandoned. Chapter I, however, was evidently a digression. It dealt with the periodic law, corpuscles, and Socialists—a somewhat somnambulistic mixture. Not our old friend the periodic law of chemistry? Yes, the very same. Not by any chance the dear old corpuscles of the blood? No, the corpuscles or electrons of the atom instead. Good! And Socialists? Ah! it was very evident from the first that they were in for it. In the sequel they were going to get it pretty badly in the neck.

* * * * *

Chapter I commenced with an excellent but solemn warning to avoid the pitfalls of humbug and falsehood. "Knavery puts on the face of justice," we are told, and "Hypocrisy and superstition wear the vizard of piety." Wondering by what O. Henry-*dénouement* the author was going to connect these aphorisms with his subject, we read on, and came to the corpuscles and a somewhat out-of-date account of the structure of the atom. For this no blame need be attached to the author. It is not right to say, however, that there are 16,000 electrons in an oxygen atom. Divide this number by 2,000. Nor can electrons penetrate "the biggest block of steel"; a quarter of an inch would stop them all. But it is not to the author's knowledge of physics that we object; it is to the application of this business of corpuscles or electrons to everything. He universalises the periodic law of chemistry, whatever that may be. He calls it God's Law, the Law of Nature. It is true and immutable. Electrons, if you please, are God's little servants, or, if you like, God's little bricks. Instead of drawing a legitimate *analogy* between positive and negative chemical elements and optimistic and pessimistic people, he goes further, and states that the differences between the pairs are due to the same cause —corpuscles. For example, if you have sixty-seven corpuscles you are a pessimist, some other number and you are an optimist. Psychologists may learn that aphasia is very simply accounted for—in one paragraph on p. 26—by corpuscles. Shell-shock is "fully explained to the Physiologist" in another paragraph on p. 29; again by corpuscles. Life and the Universe change continually as the corpuscles multiply in numbers and in series, but "the Periodic Law remains true and immutable"—yes, even when the author expresses himself thus:

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[1] *The Origin and Evolution of Freemasonry*. By Albert Churchward, M.D., M.R.C.P. (Allen & Unwin, 12s. 6d.)

* * * * *

"Take a piece of iron and heat it to 30,000° C.; presto! these little corpuscles fly off and unite with others—the moist atmosphere—and form clouds, descending again as rain to form rivers and oceans. Again, 'the dead stars' clash together, and the result an ever-increasing temperature, until it has reached a degree of 30,000° C., and lo! a new star, a new world is formed, and at that temperature all are in the form of our little corpuscles; these gradually cool down again until the chemical elements of which this world is composed are found. This evolution and devolution is repeated, but God's little servants are never destroyed, not one."

* * * * *

Then we have this new method of describing the death of a soldier in battle:

"Here, for example, is a swarm of corpuscles vibrating, scintillant, martial—they call it a soldier; and, anon, in France or Germany that swarm dissolves—dissolves, forsooth, because of another little swarm they call shells. What a phantasmagoric dance it is, these corpuscles of atoms! Mark you the mutabilities of things. These same corpuscles, or others like them, come together again, vibrating, clustering, interlocking, combining, and the result is a woman, a flower, a blackbird or shark, as the case may be. But to-morrow the dance is ended and the corpuscles and atoms are far away—some in fever germs that broke up the dance; others are the green hair of the grave, and others are blown about the antipodes on the waves of the ocean, and the eternal ever-changing dance goes on."

This is eloquence, but what has it to do with the origin of freemasonry?

* * * * *

It is not to be wondered at that the writer of these paragraphs is at times "agin" the scientists. The scientists are good enough fellows, you know, but "as a whole they have much to learn, and until they take the trouble to do so they will not make any real advancement or gain any real knowledge regarding the secrets of nature and the cosmic laws."

* * * * *

After these novel incursions into physics and physiology, we come to the Socialist, a poor creature, it appears, who attempts to explain things by "metaphysical arguments and Platonic terminology." He does not understand his "first cause," namely the Periodic Law of the Corpuscles and Elements. In other words, the poor old Socialist simply will not do.

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So much for Chapter I, and it must be confessed that a reader would find it uncommonly hard to know what on earth all this has to do with freemasonry. But this is quite typical of the class of books we are dealing with. Their characteristics are irrelevance, a spirit of I-am-right-and-nearly-everybody-else-is-wrong, and the dogmatism of whatever-I-say-three-times-is-true.

* * * * *

We are not going to deal piecemeal with the rest. By the time we arrived at the part where freemasonry is discussed, we had become too sceptical to follow the author's closely knit argument. Every now and then a statement would make us sit bolt upright, but the periodical references to the Socialist and to the Periodic Laws calmed us down. One daring statement follows another. The author talks of freemasons living 600,000 years ago; of primitive cults lasting from 100,000 to 600,000 years. Maybe, but it is a little difficult to be quite sure. Then the corpuscles swarm in upon us again, and we are told that the Periodic Laws are immutable. The author then goes on to say that the mathematicians and astronomers of to-day were surpassed in knowledge by the men who built the Pyramids. We disagree profoundly. Sir E. Wallis Budge, the great authority on Egypt, in company with the Greeks, the Romans, and all classical scholars since the time of the Romans, are hauled over the coals for not being clever enough to read the sign language of the ancient Egyptians correctly. The author thinks he can do this, and makes a shot, and his attempt is the most interesting part of the book. But we look in vain for carefulness of statement, for the scientific spirit, for the desire to collate the results obtained with those of others, for humility of spirit. Instead: "I tell you all, my Brothers, because after forty years of hard study I have been permitted to know and learn these Divine Truths, both as regards this material world and also the Divine Laws of the

Spiritual and Everlasting State, and I write for you the Truth."

* * * * *

If the matter of this book be true, we should like the author to give us a really neat definition of error. But enough. Why should this sort of thing be served up to freemasons? And if the general reader be catered for, how can he fail to be nearly as ignorant of the origins of freemasonry at the end of his reading as he was at the beginning? And the symbolism, the politics, and the chemistry which permeate it will mystify him.

* * * * *

And for this book we do not blame the author, whose courage and energy we cannot but admire, nor need we quarrel very much with the publishers. No! I think the man we want to get at is the publisher's reader who let them down by inducing them to give this book to the world.

The Ems Telegram and the Franco-German War

By A. J. Grant, M.A.

Professor of History in the University of Leeds

The Ems telegram—by which phrase is always meant Bismarck's editing and publication of the telegram sent to him by King William I of Prussia from Ems—has assumed in many quarters a fantastic importance. It is quoted as the damning proof of the mendacity of German Diplomacy; but for it, says Émile Ollivier, the French Chancellor, the war of 1870 would have been avoided; but for it, therefore, say some, the Great War, which is the continuation of the war of 1870, would have never come, and we should be living in a world ignorant of Sinn Fein and Bolshevism and a six-shilling income-tax, in a world happily unable to believe in the possibility of the agonies and the efforts of those years which already begin to seem more like nightmare than reality. It is the object of this paper to examine the real character of this famous transaction and to consider its importance.

At the beginning of January 1870 there was a moment of great relief in the international situation, which had since 1866, at least, been continuously tense and menacing. Napoleon III—prematurely old, seriously ill, without the quick imagination or the measure of will-power which he had once possessed—had made great concessions to the opposition. He had given France a new Constitution which seemed to establish something very like the English Parliamentary system, including the responsibility of Ministers. He had induced his old opponent, Émile Ollivier, to undertake the task of forming a Ministry. He had asked the nation by a plebiscite to say whether it approved of the new state of things, and 7,358,786 Frenchmen had by their votes assured him that they did. It is true that there were, even at home, black clouds on the horizon. More than a million and a half of voters had dared to vote against the Emperor in the plebiscite. Nearly two millions had not voted at all. Paris and the great towns were in opposition. Literature and thought were anti-Imperial. Victor Hugo's fulminations never ceased. But Émile Ollivier believed that the corner had been turned, and that France would now develop peacefully into a constitutional monarchy. To his sanguine temperament, the signs seemed to point to a calm in domestic politics.

He was equally hopeful in regard to foreign affairs. The tension had been very great. Four years before Bismarck and Prussia had overwhelmed Austria in the "Seven Weeks' War." Napoleon's efforts to gain for France some compensation, on the Rhine, in Luxemburg, or in Belgium, to balance the vast increase in the power and prestige of Prussia, had resulted in failure, and they had made French diplomatists, whether the Emperor or his Ministers, seem clumsy amateurs, deficient in knowledge and weak in will, in comparison with their great Prussian opponent. It was certain that Bismarck's mind was immovably set on the union of Germany under the leadership of Prussia, and that, if France resisted that project, he would gladly accept war. Many thought, like Prévost Paradol, that France and Germany were like locomotives running in opposite directions on a single line of rails, and that collision was inevitable. But Émile Ollivier's accession to the highest political office had, he hoped, changed that. He was willing to accept the union of Germany under Prussia. Why, then, should there be war? Ollivier believed that the danger was past. He told the Chamber at the beginning of July that the foreign horizon was unusually clear, and the English Foreign Office—where Lord Granville had just come into power—was of the same opinion.

All the world knows that this calm was destroyed by one of the most violent storms known to European history. It was known to the French Ambassador in Madrid, on July 2, that Leopold of Hohenzollern had accepted the Spanish throne. For twelve days France and Europe were in a constantly increasing fever of anxiety. War was practically voted by France on July 15; the Battle of Sedan was fought on September 2, and the Empire and Napoleon disappeared. It is only at the end of the Great War that we can find such a succession of catastrophes as this. The question that we ask ourselves is, "What part was played in them by the affair of the Ems telegram?"

Our knowledge of the part played by Bismarck in these great events is largely derived from his Memoirs, and it is from that source almost entirely that our knowledge of the incident of the telegram comes. The Memoirs were written or dictated in his old age, after he had been dismissed from office by the Emperor, and, like most autobiographies, they show a desire to give a certain colour to the past; they contain a fair crop of inaccuracies; and at one extremely important point they are guilty of so flagrant a suppression of the truth that it amounts clearly to a suggestion of the false. The story there given of the Ems telegram is by no means without its difficulties, and has been severely criticised by some German writers. I shall not examine these criticisms here, but shall accept those famous pages as an accurate statement. It is impossible, within the limits allowed to an article by DISCOVERY, to reproduce them. They can only be summarised.

The situation was briefly this. France had protested against a Prussian candidate for the Spanish throne, and had clearly stated her readiness to prevent the accession of Leopold of Hohenzollern, even by war. For a moment war had seemed certain. Then Leopold had been induced to resign, and the war cloud seemed lifted from Europe. Then in an evil hour, and without consulting his Chancellor Ollivier, Napoleon III had instructed his representative at Ems, where the Prussian King was taking the cure, to demand guarantees for the future. William I must declare his personal approval of Leopold's renunciation, and must promise never in the future to give the candidature his support. On this condition there would be peace, but, it was implied, on no other. Again war seemed certain, and again the danger passed. For William was conciliatory and good-humoured. He yielded something; he showed without irritation the impossibility of yielding all. The famous interview with Benedetti, the French Ambassador, passed off on the esplanade at Ems without any approach to violence of language or feeling. Benedetti was relieved. In Paris a cooler mood had come to the Imperial Council. There was a disposition to accept what had been won and to be satisfied. The King, too, believed that the crisis was past, and instructed his secretary to telegraph the result of the interview to Bismarck at Berlin. This telegram has been often reprinted, but it is necessary for the purpose of this article to print it once again (the telegram is from the King's secretary, Abeken):

"His Majesty writes to me: 'Count Benedetti spoke to me on the promenade in order to demand from me, finally in a very importunate manner, that I should authorise him to telegraph at once that I bound myself for all future time never again to give my consent if the Hohenzollerns should renew their candidature. I refused at last somewhat sternly, as it is neither right nor possible to undertake engagements of this kind *à tout jamais*. Naturally I told him that I had as yet received no news, and as he was earlier informed about Paris and Madrid than myself, he could clearly see that my Government once more had no hand in the matter.' His Majesty has since received a letter from the Prince. His Majesty, having told Count Benedetti that he was awaiting news from the Prince, has decided with reference to the above demand, upon the representation of Count Eulenburg and myself, not to receive Count Benedetti again, but only to let him be informed through an aide-de-camp: that His Majesty had now received from the Prince confirmation of the news which Benedetti had already received from Paris, and had nothing further to say to the Ambassador. His Majesty leaves it to your Excellency whether Benedetti's fresh demand and its rejection should not be at once communicated both to our Ambassador and to the Press."

Bismarck was dining with Moltke and Roon (the War Minister) when he received this telegram. He was displeased with the independent way in which the King of Prussia had conducted the negotiation, and had determined to resign office as a protest. When the telegram had been deciphered by his clerk he read it out to his guests. They interpreted it to mean that the war crisis was over, and "their dejection was so great that they turned away from food and drink." Then Bismarck asked them as to the condition of the army and received satisfactory answers. He tells us that he was himself convinced of the necessity of immediate war if Prussia was to avoid a deep humiliation. He considered in what form he should communicate the news to the Press. The King's telegram permitted him to do so, and even suggested that it should be done; but the language does not justify Bismarck in saying, as he does, that he was "commanded" to communicate it "immediately." So "in presence of my two guests I reduced the telegram by striking out words, but without adding or altering" (we will consider in a moment whether this is strictly true), to the following form:

"After the news of the renunciation of the hereditary Prince of Hohenzollern had been officially communicated to the Imperial Government of France by the Royal Government of Spain, the French Ambassador at Ems further demanded of His Majesty the King that he would authorise him to telegraph to Paris that His Majesty the King bound himself for all future time never again to give his consent if the Hohenzollerns should renew their candidature. His Majesty the King thereupon decided not to receive the French Ambassador again, and sent to tell him through the aide-de-camp on duty that His Majesty had nothing further to communicate to the Ambassador."

The new version was read out to the soldier and the statesman, and was received by them with joyous acclamation. Moltke declared that the first version had been a "parley"; this was a challenge. Roon said, "Our God of old lives still and will not let us perish in disgrace." Both regarded it as a step towards almost certain war. In the amended form it was telegraphed at once to all German Ambassadors and was communicated to the Press. It was published in Berlin in a separate slip, which was given away with the evening papers and fastened on the walls and shop windows. It was, of course, telegraphed at once to Paris, fell like a bomb on Ollivier, who was beginning to feel sure of peace, and produced such an effect on the Press and the public of Paris that the declaration of war, which immediately followed, could hardly have been avoided. We must not follow the story, but will consider these questions: (1) What was the nature of Bismarck's rehandling of the King's telegram? Does it deserve to be called forgery or falsification? (2) What was its real influence on the outbreak of the war?

(1) Was Bismarck's action forgery or falsification? It was at one time usual to speak of the "forgery" of the Ems telegram. Of late it has been often denied that it was even a "falsification." It is surely possible to come on this point to a quite definite decision. We have printed the original telegram and Bismarck's version of it which was communicated to the Press and the public. The first despatch may be analysed as follows: (1) Benedetti made demands which I refused; (2) I subsequently received official news of Leopold's renunciation of the Spanish crown; (3) so I told Benedetti that I could not see him again; (4) I leave it to you whether that should be made public or not. It is clear that this was a private telegram, and could not be published in the form in which it was received. Bismarck says that he made "no alteration in or addition to the telegram." But that judgment cannot be maintained if the two versions are closely compared. The second version says in effect: (1) Benedetti presented certain demands to the King of Prussia; (2) *thereupon* the King refused to hold further communications with him. If there is any doubt as to the wide difference between the received and the published version, it will be well to lay stress on the word *thereupon*. It is not too much to say that the published version gives a false account of an all-important incident. The King had refused to continue negotiations with Benedetti. That was certainly true. But why? The King's telegram said, because official news of Leopold's renunciation had been received. Bismarck's version said because Benedetti's demands were outrageous. The first declines to continue the negotiations because the incident has been closed by what has happened elsewhere; the second, because the negotiator has presented outrageous demands. This rehandling of the King's telegram may not deserve to be called "forgery," but assuredly it is a "falsification." Perhaps Moltke exaggerated when he called the first a parley and the second a challenge: but Bismarck and his guests were the best of judges, and they knew that the first meant peace at least for a time, and the second meant immediate war.

(2) The second question is a much more difficult one, and the answer cannot be given with certainty. What is the relation of Bismarck's action to the great war which was so soon to come? Did the falsification of the telegram cause the war or precipitate it? The word "cause" is used very loosely by historians, and a thorough examination of its meaning is seriously wanted. But no one will be found to maintain that Bismarck's telegram was in any strict sense the cause of the war. It was an incident in a long rivalry; a symptom of the anarchy of Europe; its roots stretch far back into history and into human nature. But if we see in history the operation of great causes, we must see also the occasional vast importance of small incidents; and it is a part of the task of history to establish the relation between the two.

There can be no doubt that the publication of the telegram was for the moment of decisive importance. Perhaps Bismarck's Memoirs, written in his disappointed and egotistic old age, claim for his slightest actions more importance than properly belongs to them. We have, however, in Ollivier's autobiography, which he calls *L'Empire Libéral*, evidence that cannot be set aside. Émile Ollivier was not a great man, but he was an excellent writer. His book has suffered through its immense length, for it extends to seventeen volumes. The fourteenth, which deals with the coming of the Franco-German War, can be quite well read by itself, and is one of the most fascinating pieces of political autobiography. It is supported by documents (which Bismarck's book is not) and checked by reference to other writers. His opinion is clear. He had always desired peace, and peace, which had threatened to escape him, seemed safe at last. The situation was not without difficulties—a strong current of opinion in Paris and in France would have been bitterly disappointed; but the result could not be altered. Peace was in his hands, and he hoped to go forward to establish it firmly. On the morning of the fourteenth of July Ollivier was actually engaged on a declaration which should be read to the Assembly. It was couched in a note of triumph: "To-day we are certain that a foreign prince will not sit on the throne of Spain. This victory is the more precious because it has been won by the force of reason and of right, and has not cost the sacrifice of life. . . . We asked your support against a Prussian candidate for the throne of Spain. That candidature has been withdrawn. We can now take up again with confidence the work of peace." Here let Ollivier speak for himself: "I was going on to speak of the part played by Olozaga and by Spain, when the door was opened and the usher announced 'His Excellency the Minister of Foreign Affairs' (the Duc de Gramont). As soon as he had passed the door, before ever he had reached the middle of my room, he exclaimed, 'My friend, you see a man who has just been struck in the face.' I rose. 'I don't understand you; explain yourself.' He held out to me a little sheet of yellow paper which I shall see for ever. It was a telegram from Lesourd, sent from Berlin thirteen minutes after midnight, and ran, 'A supplement to the *Gazette* of Northern Germany which came out at ten o'clock contains the following announcement.' There followed Bismarck's telegram. . . . Never was a vessel wrecked so near to harbour. I remained a few minutes silent and crushed. 'There is no room for any further illusion,' I said; 'they mean to force us to war.'" I am not here discussing the wisdom of Ollivier's policy, nor the soundness of his judgment, but merely considering the effect which Bismarck's telegram produced in France. There can be no doubt that Ollivier was devoted to the cause of peace. He says: "Drops of sweat, the result of my mental anguish, stood upon my brow. Et in agonia ego. . . . But I always came to the same conclusion. France had been insulted intentionally and grossly, and we should be faithless guardians of her honour if we tolerated it." The news had meanwhile spread to the boulevards, and on all sides were heard cries of "Vive la guerre! À Berlin!" The decision of the Assembly and the declaration of the Emperor did but ratify the opinion of the Ministers and of France.

It is, then, certain that the publication of the telegram was the occasion which inflamed the war fever in Germany (where the incident at Ems was regarded as an insult to Prussia) and ruined the hopes of the French Chancellor. But that is far from saying that it was the cause of the war. If the telegram had not been published, what course would events have taken? There would have been a precious moment in which the basis of a real pacification might have been laid, especially if Bismarck had carried out his threat of resigning office. Ollivier might have shown himself possessed "of the genius of Cavour and Bismarck combined" (the phrase was used of him by a correspondent, and he quotes it with characteristic naïveté). On the other hand, it is possible—and probable—that a new crisis would very soon have arisen—there had been a series of Franco-Prussian crises since 1866: that Ollivier, who only possessed half of Napoleon's confidence, would have failed to deal with it, and that war would have entered a little later by a slightly different gate.

The ethical aspect of the incident may be briefly dealt with. Bismarck's action has been represented as an unparalleled act of diabolical cleverness. No diplomatic incident has acquired such celebrity. During the Great War it was constantly used as a weapon wherewith to beat the policy and diplomacy of Germany. Now that the passions of that time are dying down, it is possible again to see the incident in its true light. Bismarck had in his hands at that moment peace and war: he chose war; and he obtained it by falsifying the account of the interview between his King and the French Ambassador. That is a terrible responsibility. But European history would not be the crime-laden record that it is if his action stood out in solitary infamy among the doings of statesmen and diplomatists. It is not difficult to understand how Germany can forgive a statesman who by a stroke of the pen brought on, at a moment favourable to his own country, a war which he believed to be necessary and inevitable. There are far worse incidents in the career of Frederick the Great. Are not many incidents quite as bad to be found in the records of English statesmen, crowned and uncrowned, whom posterity has made up its mind to honour?

The Structure of the Atom

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In chemistry an element may be defined as a distinct kind of matter that has not yet been shown to be composite. Pure gold, for example, is called an element because no one has yet succeeded in showing that it is really made up of two or more other substances. Brass, although, like gold, a metal and resembling it somewhat in appearance, is not an element, because it is made from copper and zinc, and may be easily changed back into these metals. Oxygen gas, although about as different from gold as anything could be, resembles it in one respect at least. It is an element. Water, on the other hand, which contains oxygen and hydrogen in combination, can easily be shown to be a compound. By passing an electric current through it its elements, hydrogen and oxygen, are obtained.

An element or an elementary substance is supposed to be an aggregate of minute particles which are called atoms. These atoms are supposed to be the same in every respect; they are indivisible. What they look like is of no importance, for nobody will ever see them—they are much too small—but most people imagine them as little hard spheres like tiny balls of steel. All atoms of any particular element have the same size and weight, but the weights of atoms of different elements are very different. The atom of uranium, the element whose atom is the heaviest, is 236 times that of hydrogen, the lightest; that of iron is three and a half times heavier than that of oxygen; that of oxygen is four times the weight of the atom of helium; that of helium nearly four times that of hydrogen.

These weights cannot conceivably be measured directly, i.e. by weighing the atoms singly in turn. The atomic weight of an element has to be determined indirectly, following certain laws and assumptions which are at the very root of the science of chemistry. How this is done need not concern us here. Suffice it to say that when the atomic weights of different elements are determined, these values are expressed not as very small fractions of a very small weight such as an ounce, a grain, or a gramme, but more simply as numbers on a scale. One must remember that these numbers, although called "atomic weights," are for purposes of comparison only. They are not the actual weights of the atoms. The atomic weight of oxygen is chosen as 16. It is the standard of comparison. Uranium is then found to have an atomic weight of 238, so that the uranium atom is $\frac{238}{16}$ times heavier than that of oxygen. Lead has an atomic weight of 207; tin of 119; copper, 63; iron, 56; chlorine, 35·5; nitrogen, 14; and hydrogen just a little greater than 1. From these numbers one can work out, if one wishes, the relative weights of these elements with regard to each other or to oxygen. With a table of the atomic weights of the elements before one, a glance is sufficient to show what are the relative weights of the elements, and it is as easy to arrange the chemical elements in increasing order of their atomic weights as it is to arrange a series of numbers so that each is less than the one which follows it.

Why is one atom heavier than another? One simple answer to this question was that given by the chemist Prout. He imagined that all the elements were in some way built up of hydrogen atoms; consequently, the more hydrogen atoms it contained, the heavier was the atom. But if an atom be composed of a number of the lightest (hydrogen) atoms, it must be composed in a very special way, for if it is a composition of the kind usually met with in chemistry, one would imagine that in time someone would manage to split it up into simpler parts. This, however, has not been done. An element is an element, and cannot, except in a very special manner, as we shall see later, be split up. Without passing any judgment on this idea of Prout's, let us answer the question by saying that one atom differs in weight from another because it has a different structure.

Now, the structure of the atom is so new a subject that it will be several years yet before one has a pretty definite theory of just what that structure is. A short account of the principal points of the theory may, however, be given now. It represents in outline the present ideas.

The atoms of all the elements are supposed to have the same general structure. A description of one atom, therefore, answers for a description of all. An atom is supposed to be composed of positive and negative electricity only. The positive electricity is supposed to be at the centre of the atom, forming a core there; or, as it is called, a nucleus. Surrounding this nucleus are separate particles of negative electricity (called electrons), which are spaced out to occupy the rest of the atom. The important things about the nucleus are: (*a*) its size, which is very minute compared with the size of the atom; (*b*) the fact that "practically the whole" of the mass (or weight) of the atom is concentrated on this tiny nucleus, paradoxical as this may appear to be; and (*c*) the fact that the nucleus may have in it both negative and positive electricity "slumped together"; but it appears to be positive electricity only, because there is always more of the latter than of the former. The negative electricity, on the other hand, is not "slumped together," but exists as separate little entities (electrons), which may revolve round the nucleus analogously to the movement of the planets round the sun, or may simply be stationary. The size of each of these entities of negative electricity is very small compared with the diameter of the atom, but it is somewhat larger than *the whole* of the positive nucleus. As there is but one nucleus, and as the number of electrons in an atom is never greater than 92 (experiment proves this), and as all are very minute compared with the size of an atom, it follows that most of an atom—more than 99·99 per cent. of it—is empty space. Consider an atom so magnified as to appear superficially like Ireland. On that scale the nucleus, situated at Athlone, would be a ball of 8 feet in radius only. Round that, at different distances from Athlone to the sea, would be some forty or fifty (on the average) spheres of about the same radius, and *these and the nucleus are the whole of the atom.*

An atom, then, in some respects resembles the solar system. The solar system, if you come to think of it, is mostly space ; for the distances between the planets, and between each planet and the sun, are enormous compared with the size of the planets or of the sun. It resembles it further in this, that very probably the electrons revolve round the nucleus in the atom, like planets round the sun. But the analogy need not be pressed further.

The *amount* of positive electricity on the nucleus of the atom, and the *number* of electrons in the atom, are invariably the same numerically. Thus, an atom whose nucleus has a charge of 22 positive units has 22 electrons. The lead atom, for example, has 82 positive charges on its nucleus and 82 electrons ; the oxygen atom 8 positive charges on its nucleus and 8 surrounding electrons ; the helium atom 2 and 2 ; the hydrogen atom 1 and 1. This number, which is both the number of electrons in the atom and the number of positive charges of electricity on the nucleus, is an important one. It is called the Atomic Number. Each element has one atomic number and one only ; its chemical and physical properties depend upon this magnitude, for they depend solely on the *amount* of the charge on the nucleus. Change the atomic number (if you can), and you change the chemical and physical properties of the body ; that is, you make a new element.

I have tried to show, then, that atoms differ in weight and chemical properties because of slight differences in their general structure. These differences are occasioned by differences in the number of positive charges on the cores or nuclei of the different atoms, and concurrently with this, in the number of electrons which surround the nuclei.

This important number, the Atomic Number, is very easily obtained. One simply arranges the whole of the elements in increasing order of their atomic weights, and numbers them off from the lowest like soldiers. Hydrogen is the element of lightest atomic weight. Its atomic number is therefore 1, its nucleus has a charge of 1 positive unit of electricity, it has 1 electron. Helium is the next lightest. Its atomic number is therefore 2, its nucleus has a charge of 2 positive units, it has 2 electrons. Lithium is the third lightest, hence, etc. Iron stands twenty-sixth in order of lightness of atoms. It has therefore a charge of 26 positive units on its nucleus, and 26 electrons. The statement applies to every element. Uranium, the heaviest of the elements, stands ninety-second in order. Its nucleus has 92 positive charges, and round it are its 92 electrons.

Note that it is not the number of electrons (each of which is probably the same in size whatever atom it occurs in) that makes the weight of the atom. The electrons are supposed each to have a weight of only $\frac{1}{1830}$ of that of the lightest atom, so that their weight is negligible. The seat of the weight of the atom, as I mentioned above, lies in the nucleus. Each positive charge of electricity corresponds to from 2 to 2½ units of atomic weight, depending upon whether the atom be light or heavy. Oxygen, for example, has an atomic number of 8 and an atomic weight of 16 ; tin an atomic number of 50 and an atomic weight of 119 ; lead an atomic number of 82 and an atomic weight of 207.

The transmutation of the elements is a subject that has always appealed to the imagination of man. Many people spent their valuable lives during the Middle Ages attempting to make the noble metals out of the baser sort. Seventeen years ago a firm in Scotland, with a capital of between £50,000 and £100,000, tried the experiment also as a side line to their proper work. The present theory of the structure of the atom, had they known it, would have convinced all these alchemists that the difficulty of transmutation was greater than they may have imagined, even in their most pessimistic moments.

Gold has an atomic number of 79, mercury of 80. To transmute mercury, which is comparatively cheap, into an equal weight of gold, all one has to do, if the present theory be true, is to reduce its atomic number by one. To do this one has simply to knock out one of the positive charges from the nucleus of mercury. This will reduce the nucleus to 79 charges, and I am quite sure the 80 surrounding electrons will then take up a new set of positions, and expel one of their number so that they too will number 79. The body with the nucleus of 79 charges will be gold. No possible doubt whatever about that. The great difficulty is to knock out that single charge from the nucleus of the atom of mercury. That is extremely difficult. Why ? Well, first of all, you have to get hold of some tiny projectile corresponding to the ball (now, alas, twopence !) that brings down the cocoanut. This must be something small because it has to penetrate the atom. A tiny atom would do, helium or hydrogen for example. Next, this small atom, in order to penetrate bodies, must be moving with a considerable velocity, since it is hitting the " outsides " of other atoms at every stage and so losing velocity. The next difficulty is that the nucleus is so small compared with the size of the atom, being " mostly empty space," that only one shot in many millions is likely to hit the nucleus. Most shots will go right through the atom and miss the nucleus altogether. To be near is not enough. The near shots are simply bent round the nucleus as a comet is deflected round the sun. Once, however, the nucleus is really hit with sufficient energy by the projectile it is likely to be broken up. It will lose some of its electric charge, and so will form with its new set of surrounding electrons a different atom.

Repeat the process often enough, and you may obtain enough of these broken atoms to form a weighable amount of a different substance. In the case of mercury (atomic number 80), you might produce in this way gold (atomic number 79), or perhaps platinum (atomic number 78).

Professor Rutherford, of Cambridge, has shown that artificial transmutation of one element into another by the method sketched above is possible. In his experiments he used as projectiles the high-speed particles spontaneously emitted by the radio-active element, radium C. These particles consist of atoms of helium moving with a velocity of some 12,000 miles per second. The atoms struck were those of the element nitrogen (atomic number 7). Professor Rutherford showed that from a very small percentage of these atoms, atoms of hydrogen were produced. It is believed that these are produced by the rupturing of the nucleus of the nitrogen atom by the high-speed particles of helium. This is the first occasion on which artificial transmutation of one element into another has been successfully carried out. Further work along these lines is, of course, merrily in progress.

Legal Minimum Wages

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I

THE whole problem of wages is very much to the fore at the present time, but it is only with one aspect of the problem that I am immediately concerned. In order, however, that the question of legal minimum wages may be seen in its proper perspective, it will be necessary to touch briefly on the larger questions of (*a*) the state regulation of wages in general, and (*b*) wages settlements by conciliation and arbitration.

At the outset I wish to make clear what is understood by "legal minimum wages." The expression implies two things: (1) that rates of wages have been fixed by Parliament, or by some body or person charged with that duty by Act of Parliament, and (2) that any employer paying lower rates than those legally fixed is liable to a penalty in accordance with an Act of Parliament. A legal minimum rate may be contrasted with (*a*) a standard rate, i.e. a rate normally paid in a particular occupation, and (*b*) a maximum rate, i.e. a rate which may not be exceeded under penalty. A standard rate is commonly fixed by agreement between organisations of employers and workers, or by arbitration; thus the 2*s*. 5*d*. per hour paid to plumbers in Liverpool may be quoted as an illustration of a standard rate. Maximum rates existed long before standard rates or minimum rates were thought of, but the last Act regulating the subject was repealed about 100 years ago. The wages assessments issued by the Justices of the Peace under the Statute of Apprentices, 1563, all represented cases of legal maximum wages. The penalty for giving wages higher than the rate was ten days' imprisonment and a fine of £5; the penalty for receiving wages higher than the rate was twenty-one days' imprisonment. A Warwickshire Wages Assessment in 1738 fixed the rate for a mason in summer at 10*d*. a day with drink, and at 1*s*. a day without drink. The 10*d*. and the 1*s*. are illustrations of legal maximum wages.

The conception of a legal minimum wage, dissociated entirely from any legal maximum wage, is quite modern. It was suggested as a means of dealing with the problem of "sweated" labour. The mere pittances paid to certain classes of labour, especially to women, more particularly those working at home, or employed by sub-contractors, had become sufficiently recognised as a public scandal to cause the Government to move in the first decade of the present century. In 1907 a commissioner was sent to Australia to investigate the Wages Boards established there, and in 1908 the House of Commons appointed a Select Committee on Home Work. It was on the recommendation of this Committee that the Trade Boards Act, 1909, was passed.

The Act might be applied to any specified trade if the rate of wages prevailing in any branch of the trade was exceptionally low as compared with that of other employments. At the outset four trades were covered by the Act: tailoring, paper-box making, lace finishing, and chain-making. In 1913 linen and cotton embroidery, hollow-ware making, sugar confectionery and food preserving, and tin-box making were brought under the Act. The number of workers affected in these eight trades was about 400,000. One of the worst cases of an exceptionally low-wage occupation, viz. agriculture, was not provided for until 1917, when an Agricultural Wages Board, with power to fix legal minimum wages, was established under the Corn Production Act, 1917.

A new aspect of the problem of legal minimum wages dates from 1918, when a new Trade Boards Act was passed, which could be applied by the Minister of Labour to any specified trade in which no adequate machinery existed for the effective regulation of wages throughout the trade. In other words, whilst the Trade Boards Act, 1909, applied to "sweated" trades, the Trade Boards Act, 1918, applies to badly organised trades. The Minister of Labour has made, and is making, considerable use of his powers under the new

Act, and it is estimated that by the end of this year some three million workers will be covered by Trade Boards. Included amongst these workers are those employed in grocers' shops, in laundries, in tobacco factories, in aerated water works, in jute, flax and hemp mills, in boot and shoe repairing, and in the distribution of milk.

Before dealing more fully with the constitution and functions of Trade Boards, reference must be made to two other ways in which the State of recent years has participated in the regulation of wages. (1) Under the Munitions of War Acts, 1915 to 1917, arbitration tribunals with compulsory powers were established. The Committee on Production was probably the best known of these tribunals. These arbitration tribunals fixed standard rates; failure to comply with the decisions was punishable by penalties through a Munitions Tribunal. This system of compulsory arbitration was largely done away with after the Armistice, though it was not finally abolished until Sept. 30, 1920. (2) From time to time the Government arranges for the holding of an impartial investigation with regard to the proper rates of remuneration in some particular occupation. Any recommendation made by such committee or Court has no binding force, but it is hoped that the parties concerned will accept it of their own accord or as a result of the pressure of public opinion. The Burnham Committees on teachers' salaries and the Court of Inquiry on dockers' wages may be mentioned as illustrations of this type of procedure.

II

The first step to be taken in order to fix legal minimum wages in a trade is to establish a Trade Board for that trade. A Trade Board consists of members representing employers and of members representing workers in equal numbers, and of three (occasionally five) independent persons—generally professional men or women—known as the "appointed members." The Chairman and Deputy Chairman are always selected by the Ministry of Labour from amongst the "appointed members." The size of the Boards varies: on the Button-making Trade Board, for example, there are 16 on the employers' side and 16 on the workers' side, together with 3 "appointed members"; whilst on the Grocery and Provision Trade Board there are 39 on the employers' side and 39 on the workers' side, together with 5 "appointed members."

A Trade Board's method of reaching a wages settlement lies in between the methods of conciliation and arbitration. Arbitration may be defined as an authoritative decision of an issue, as to which the parties have failed to agree, by some person or persons other than the parties. Conciliation, on the other hand, is the discussion and settlement of a question between the parties themselves, or their representatives, who are actually interested.

A Trade Board seeks to reach its decisions by agreement between the two sides, with or without the assistance of the "appointed members" as intermediaries. If successful, it acts like a Conciliation Board with an independent Chairman. On the other hand, it differs from a Conciliation Board in that, if the two sides do not agree, instead of a deadlock resulting, a decision can usually be obtained by voting; each member of a Trade Board has a vote, and if there is no cross-voting between the two sides, the votes of the "appointed members" should give a majority in favour of the proposals or of the counter-proposals before the Board.

The fact that the "appointed members," as well as the representative members, have votes does not make the "appointed members" into arbitrators—they have no power to give an authoritative decision. If the two sides are evenly divided on some question the "appointed members" can turn the balance in favour of one side or the other, but they cannot impose upon the trade some settlement which has the support of neither side on the Board.

The Trade Board method of reaching wages settlements appears to have certain advantages over the arbitration method:

1. A Trade Board cannot give a decision which is disapproved of by both employers and workers, which may quite well be the case with the decision of an arbitration tribunal.

2. A Trade Board, when once established, is a permanent body which meets periodically. The results of this, apart from enabling the two sides to get to know each other, which is likely to facilitate the securing of decisions by agreement, are as follows: (*a*) The "appointed members" have an opportunity of acquiring some knowledge of the trade for which they legislate, whereas the independent members of an arbitration tribunal are almost necessarily ignorant of the industry under consideration. (*b*) A Trade Board deals with any particular wages question from its earliest inception, whereas an arbitration tribunal does not handle a wages question until it has reached an exceedingly acute stage—which makes it far more difficult to find a satisfactory solution. (*c*) A Trade Board is responsible for the carrying out of its own decisions. If it makes mistakes it has sooner or later to rectify them. It consequently tends to be cautious in its decisions and to feel its way carefully. An arbitration tribunal, on the other hand, is set up for a particular purpose; once its decision is given, it has no further interest in the particular problem; how its decision will work, and what its effects on the trade

will be, are not its concerns. Under these circumstances it is hardly surprising that arbitration awards are sometimes a greater source of trouble than the original disagreements which were submitted to arbitration.

3. A separate arbitration tribunal being constituted to deal with every dispute, there is a serious danger of a great divergence in the decisions reached by arbitration. Thus one tribunal may fix women's wages at one-half of the men's rates, another at two-thirds of the men's rates, and still another at four-fifths of the men's rates. In a similar manner, diversity may occur in the solution of all the problems submitted to arbitration, and the more this happens the more dissatisfaction there will tend to be.

Obviously there can be no question of absolute uniformity in the decisions of the various Trade Boards. Had that been desired, it would have been necessary to set up one Trade Board for all trades, instead of a separate Trade Board for each trade. Each Trade Board has its own problems to solve and must deal with them on their merits. Nevertheless, the fundamental principles underlying the various decisions will tend to be the same, and it should be possible to secure some degree of uniformity. As a matter of fact, this is achieved in a considerable measure by the thirty odd Trade Boards in Great Britain as a result of three co-ordinating influences:

(*a*) The same men and women commonly serve as "appointed members" on several Boards, and thus tend to keep the different Boards in touch with each other.

(*b*) One man is secretary of all the Boards, and he or his deputy is always willing, if invited to do so, to place his intimate knowledge of the working of all Trade Boards at the disposal of any particular Board.

(*c*) All rates fixed by Trade Boards have to be confirmed by the Minister of Labour before they can come into force. This does not mean that the Minister seeks to dictate to Trade Boards what they shall do, but that he is responsible to Parliament for seeing that Trade Boards do nothing which is not expressly authorised by the Trade Boards Acts. How the check on Trade Boards works in practice depends very much upon the broadmindedness with which the permanent officials at the headquarters of the Ministry of Labour discharge their functions. These officials, unlike the secretary and the "appointed members," are not in close touch with the employers and workers on the various Boards, and there is always a danger that, instead of taking a common-sense point of view of any particular problem, they will adopt a narrow-minded and strictly legalistic attitude and strive to follow the letter rather than the spirit of the law. In such a case the Ministry would tend to devote much of its time to solving such riddles as "When is overtime not overtime?" or "When is a week not a week?" and in inflicting its solutions of the riddles upon the various Boards.

In practice, the control of the Minister of Labour, through his power to refuse to confirm the proposals of Trade Boards, appears to act as a check in minor rather than in major matters.

III

The problems which face Trade Boards, and more especially the "appointed members," appear to be a good deal more difficult to-day than they were a few years ago. (*a*) Before the war the Boards were concerned only with "sweated" industries; now they are frequently concerned with industries of a higher type, and there is a tendency to invoke the machinery of a Trade Board to help not merely the lower-wage, but also the higher-wage, sections of the workers. Whereas an old Trade Board, such as the Hollow-ware Board, has fixed only one rate for men and one rate for women (apart from overtime), a new Trade Board, such as the Button-making Board, has made special provision for skilled workers and for piece-workers; thus there is one time-rate for unskilled men and a higher time-rate for skilled men, and a further provision that where skilled men are paid piece-rates, the rates must be so fixed as to enable men to earn at least "time and a quarter." At the present moment certain retail trades are being brought within the scope of the Trade Boards Acts, and the complexities with which the "appointed members" are faced appear to be greater than ever. (*b*) The great instability of prices to-day, as compared with pre-war days, seriously magnifies the work of the Trade Boards.

If, after discussions and negotiations, the two sides of a Board can agree about any particular matter, the "appointed members" feel that they are relieved of any responsibility for the decision reached, and that they have done their share of the work in helping forward the negotiations which have led to the agreement.

If, however, after discussion and negotiations, the two sides of a Board do not agree about some essential matter, such as the fixing of general minimum time rates, then a very serious responsibility falls upon the "appointed members," who can, apparently, adopt one of three courses: (1) they can vote in favour of the proposals of either one side or the other, and thus enable the Board to reach a decision; (2) they can refrain from voting, or can vote against both sides, if they feel that they cannot support the proposals of either side, and instead they can put forward tentative suggestions of their own, in the hope of being able to win one side, if not both sides, to voting for them, or some modification of them which may seem acceptable; (3) in the last resort, they can report to the Minister of Labour that the Board is unable to fix general minimum time rates.

It not infrequently happens that, either formally or informally, the "appointed members" have to put forward suggestions for the consideration of the two sides, with a view to bridging differences. By what principle, it may be asked, are the "appointed members" governed in making their suggestions with regard to wages? At the outset it should be stated that the Trade Boards Acts appear to contain no instructions for the guidance of Boards, but the Corn Production Act has a sub-section to the following effect: "In fixing minimum rates . . . the Agricultural Wages Board shall, so far as practicable, secure for able-bodied men wages which, in the opinion of the Board, are adequate to promote efficiency and to enable a man in an ordinary case to maintain himself and his family in accordance with such standard of comfort as may be reasonable in relation to the matter of his occupation."

I cannot attempt to lay down the principles on which a Trade Board should act in determining minimum wages, but I venture to suggest that the following considerations, among others, are likely to have weight with the "appointed members," if not with a Board as a whole:

1. The need for enabling a worker to maintain a reasonable standard of life. Even in the case of a minimum wage, something more than a mere subsistence allowance, in the sense of what is necessary to keep the body and soul of the worker together, should be aimed at; but it is hardly possible, when dealing with a minimum wage, to accept the view of the Dockers' Court of Inquiry which had reference to standard wages. That Court held that dockers had "a right to have life ordered upon a higher standard [than merely a subsistence allowance], with full regard to those comforts and decencies which are promotive of better habits, which give a chance for the development of a greater sense of self-respect, and which betoken a higher regard for the place occupied by these workers in the scheme of citizenship." What exactly this standard amounts to, in terms of the necessaries, comforts, and luxuries of life, was not stated. Dr. Bowley, Professor of Statistics in the University of London, estimated 73*s*. 6*d*. out of London, and 77*s*. in London, as the expense of procuring a decent standard of life for a family of a man, wife, and three children. The Court, in March 1920, recommended 16*s*. a day, or 88*s*. a week.

2. Variations in the cost of living. This was recognised already in connection with the wages assessment made under the Statute of Apprentices. The Justices, before settling wages, were to call unto them "such discreet and grave persons of the . . . county or city as they should think meet," and they were to confer together "respecting the plenty or scarcity of the time." Nowadays, members of Trade Boards consult the latest number of the *Labour Gazette* to ascertain the most recent figure for the percentage increase in the cost of living since July 1914.

3. What the best employers in the particular trade are already paying.

4. The existing rates of remuneration of occupations of similar standing in other trades.

5. What wages the particular trade will bear. This consideration raises a variety of possibilities:

(*a*) The possibility of the increased wages bill being passed on to the consumer in the form of higher prices.

(*b*) The possibility of less efficient workers being dismissed.

(*c*) The possibility of smaller employers being eliminated and displaced by larger employers.

(*d*) The possibility of the industry being handicapped in its struggle with foreign competitors.

(*e*) The possibility of labour being displaced by machinery.

(*f*) The possibility of higher wages rendering labour more efficient so that a corresponding, or even more than corresponding, increase in output is secured.

(*g*) The possibility of the increased wages bill being met entirely out of profits.

(*h*) The possibility of the higher wages acting as an inducement to employers to reorganise their businesses, with a view to eliminating wasteful methods.

6. Variations prevailing in different parts of the country, both in respect of cost of living and in respect of what the trade will bear, more especially in the case of those trades, such as the grocery business, which are carried on in all types of area, from the biggest town to the smallest country village.

7. The grading of the workers within any particular trade, if more than the lowest grade is to be given protection. If the workers in a trade can be roughly divided into two classes, skilled and unskilled, the problem of the relation of the wages of the higher to the lower grade is not very serious; if, however, it is necessary to distinguish several distinct grades, as apparently in the grocery trade, then the work of securing the proper proportions between the wages of the different grades, without making the rate for the lowest grade too low, or the rate for the highest grade too high, is a task of considerable difficulty.

8. In the case of rates for juveniles, care must be taken not to fix wages in such a manner as to promote wholesale dismissals when youths become adults. At the same time, rates must not be fixed so high as to deter employers from engaging juvenile labour, nor so low as to deter juveniles from entering the trade.

9. In the case of rates for women, an attempt has

probably to be made so to adjust women's wages to men's wages, as not to offer any strong inducement to employers to substitute either women for men or men for women.

In view of all these conflicting considerations and possibilities, it must be obvious to everyone that only a body of supermen could fix wages which would be absolutely fair to all parties concerned. A Trade Board is probably justified in considering that it has done its work well if it is able to reach a settlement which is acceptable to a majority of the employers and workers in the trade. Experience seems to show that even a proposal which has met with strong opposition inside a Board may meet with a fairly good reception from employers and workers outside the Board. This provides at least some comfort to the "appointed members" when they are obliged to vote.

IV

In conclusion, it may be asked whether or not a great extension of the system of fixing legal minimum wages is desirable. Some would undoubtedly prefer to restrict the system to "sweated" industries, but as the Minister of Labour is busily engaged in extending the system, it hardly seems the best moment to discuss on first principles whether the policy is wise or not. For the time being, we have to accept the large increase in the number of trades covered by Trade Boards as an accomplished fact. In another year or two, enough information concerning the working of the new Trade Boards may be available to enable a fairly reliable opinion to be formed as to the wisdom of the policy. But one thing seems fairly certain: a very wide or universal extension of the system of legal minimum wages, though it may lead to the removal of some wages anomalies, will not prove a panacea for the most serious economic ills from which we are at present suffering. If the money incomes of the whole, or of the great bulk, of the population were doubled to-morrow, nobody would be any better off, as the real income of the country, the goods and services available for purchase, would remain unchanged. If increased money incomes were secured for a small section of the community, then the position of that section would be improved—at the expense of the rest of the community. If the object is to benefit the great bulk, or the whole, of the community, the fundamental problem is how to increase the national output of goods and services, which constitute the real income of the country. Without this, no rise in the general standard of living would appear to be possible. Whether a wide extension of Trade Boards can help in increasing the national output experience alone can show.

Temporary Stars

By Donald W. Horner, F.R.A.S.

THE recent discovery by Mr. W. F. Denning, F.R.A.S., of Bristol, on August 20, 1920, of a new star in the constellation of Cygnus has caused some unusual interest to be taken in novæ in general, and Nova Cygni in particular, so that it may be well to give a short résumé of the matter in the pages of DISCOVERY.

The new star discovered this year by Mr. Denning was at that time in the northern region of Cygnus, at R.A.[1] 19h. 56m. 24s. and declination N. 53° 24′. The star, which was when first seen about 3½ magnitude, was increasing in brightness, and reached a maximum on August 24, when it was of the 1·8 magnitude,[2] as observed at the Royal Observatory, Greenwich. A decline in lustre then occurred, so that by the end of August the magnitude was only 4½, and by September 14 it had fallen to 5½, and was only faintly visible to the naked eye.

It is still being observed at the time of writing (October 1920) at all the chief observatories in England and abroad, and has aroused a remarkable extent of interest. In the years of the future it will continue to be examined as a small telescopic star, or possibly a nebula, for some of these novæ apparently display a nebulous appearance in their later stages.

New stars shone out in Cygnus on two occasions in past history, namely in August 1600 and in November 1876.

It is interesting to recall in this connection that the first authenticated appearance of a new, or temporary, star was in 134 B.C., and this star is said to have burst out quite suddenly in the heavens with a brilliancy sufficient to render it visible in broad daylight.

This star attracted the attention of Hipparchus, and caused him to make a catalogue of the stars (the first of its kind), with the object of enabling future astronomers to trace with ease and certainty subsequent apparitions of new stars.

In ancient times there seems to have been some confusion existing in the minds of the astronomers of those days between new stars and comets, and sometimes an appearance of the former object is mentioned when it is fairly obvious that the latter was the actual phenomenon witnessed.

It seems reasonably certain, however, that the apparition of 134 B.C., and also a new star which appeared in the constellation of Cassiopeia in 1572, were really novæ and not comets. The latter star would appear the most remarkable of its kind that has been put on record.

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[1] Right Ascension

[2] The numbers expressing magnitudes decrease as the magnitude of the star increases.

On November 11, 1572, the day it was first discovered by Tycho Brahe, its brightness was as great as that of Sirius, and it rapidly increased until it was brighter than Jupiter, and soon became visible in the daytime. After this, however, it gradually faded away and disappeared after a lapse of sixteen months.

Coming to modern times, the most notable new stars previous to the recent discovery of Mr. Denning was Nova Aurigæ, discovered by Dr. Thos. D. Anderson, of Edinburgh, in 1892; and Nova Persei, which was first discovered by the same astronomer on the morning of February 22, 1901, and later in the evening of the same day by Mr. Ivor Gregg and Dr. J. Ellard Gore.

There are many theories to account for these sudden outbursts in space, of which perhaps the best known is that of Prof. A. W. Bickerton, which is known as the *Grazing Contact Theory* or the *Theory of the Third Body.*

In this theory the origin of the new star is said to be that the innumerable bodies forming the stars of the Milky Way travel in two great streams in opposite directions, and from time to time two of these suns meet with an appulse or grazing collision, pieces of the colliding stars being torn off, and, becoming explosively hot, coalesce into a new and third body of great brilliance, which makes what we call the new star, and the two colliding suns pass on their way.

What seems most extraordinary to the uninitiated is the fact that the collision, or whatever it may be that caused the outburst which we see as a new star, probably occurred some hundred or even two hundred years previously, the light of the mighty explosion having taken that interval of time to cross space even at the tremendous speed of 186,330 miles per second, or about 670,000,000 miles an hour. From this we see that an appulse of two suns may be now taking place in the region of the Galaxy which will not be viewed by either the present generation or the next.

The part of Prof. Bickerton's theory which assumes two great opposing streams of stars in the Milky Way has been confirmed by the observations of Prof. Kapteyn and other distinguished astronomers, but the portion dealing with the grazing contact of two suns still awaits substantiation. It was the new star which flashed out suddenly in Corona Borealis in 1866, and which was called the "blaze star," that led to the investigation of these phenomena; and it would seem that in most cases of this kind the "new stars" are mainly due to the revival from some unknown cause of a star already existing in space.

It is of course not necessary, if we accept the grazing contact theory, to bind ourselves down to appulses of solid bodies; the temporary star might equally well be due to a collision between a star and a nebula, or even between two nebulæ.

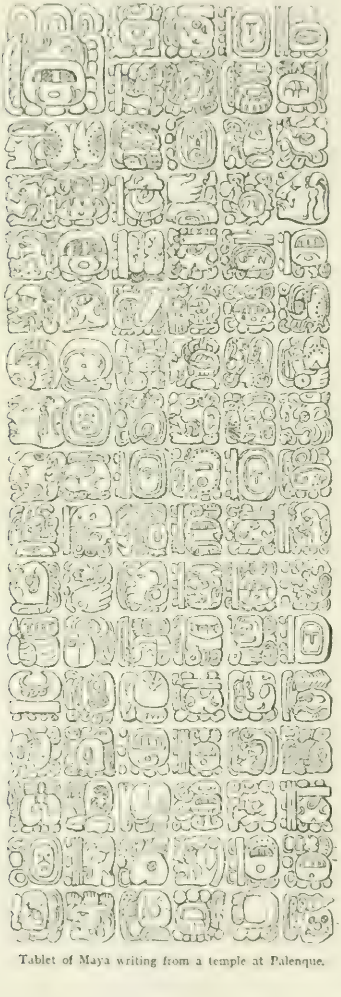
It may occur to some readers that if it be possible for collisions to take place in space it might one day happen that our own Sun would meet with an appulse from some unknown and possibly dark body. This contingency has not been overlooked by astronomers, but it has been found that whilst the suns in the region of the Galaxy lie in comparatively close juxtaposition there are no suns lying in close proximity to our own luminary. The late Mr. J. Ellard Gore, F.R.A.S., calculated that the chances against our Sun colliding with another body in space was 15,000,000 to 1, so that we need hardly fear the possibility of ourselves making a "temporary star" for the benefit of possible astronomers in another system in space!

The Hieroglyphs of Central America

By Lewis Spence, F.R.A.I.

Author of "The Civilisation of Ancient Mexico," "Myths of Mexico and Peru," etc.

The strange system of writing anciently in use among the civilised peoples of Central America has not succeeded in attracting the same degree of popular interest in this country as the scripts of Egypt or Assyria, yet its claims upon the imagination are, perhaps, no less strong than those of hieroglyphic or cuneiform. Our grandfathers waxed enthusiastic over the amateur explorations of Stephens among the crumbling cities of Yucatan and Chiapas, but although the governments of the United States, France, and Germany have freely encouraged research in American archæology and its cultivation flourishes abroad, it still languishes among us. It is regrettable that British readers should remain unfamiliar with results so surprising and so creditable to human perseverance as those which have recently attended the discovery of the general purport of the Maya glyphic system. For the pursuit of this quest a far greater degree of effort and a higher ingenuity have been needful than was the case in the unriddling of the ancient writings of Egypt or Sumeria. That the quaint symbols of the ancient Maya have so far met with only partial interpretation is, perhaps, one of the reasons why they fail to excite more general interest. But surely the privilege of watching the gradual revelation of these obscure glyphs is one on which our generation should place a higher value than it appears to think the opportunity merits.



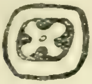
Tablet of Maya writing from a temple at Palenque.

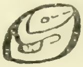
The localities of Central America in which monuments bearing the involved and fantastic characters of this script are most generally found are still inhabited by people of that Maya stock who once employed it. They embrace the remote peninsula of Yucatan, the uplands of Guatemala, and the districts of Tabasco, Chiapas, and even a portion of Honduras. But by far the greater number of inscriptions have been met with in the southern part of these provinces, where the older branch of the Maya civilisation originally flourished. It is at such sites as Copan in Honduras, Quirigua and Tikal in Guatemala, and Piedras Negras and Palenque in Chiapas that important texts are found, rather than in Yucatan proper, although inscriptions of moment are not wanting at Uxmal, Chichen Itza, and elsewhere in the northern spheres of Maya influence.

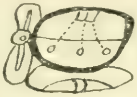
Just as the ancient writings of the Middle East are found inscribed on a variety of objects, so the Maya script is not only painted on paper or skin or carved on stone, but incised on wood, bone, shell, metal, and modelled on pottery. The mediums of stone and paper were the most popular among the Maya scribes, and all others may be dismissed from our consideration. The carven inscriptions usually occur upon the sides of monoliths known as stele-shafts, which in shape, if not in their wealth of ornamental detail, recall the menhirs of Brittany. On altars, staircases, and frequently on the walls of temples and palaces, they are to be found nestling among the florid reliefs typical of Maya architecture. But the writing proper is confined to the few manuscripts or codices rescued from the pious attentions of the early Spanish ecclesiastical authorities and now in European museums or libraries.

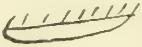
The shape of the glyphs or symbols as they occur in the carven examples differs somewhat from that employed in the written character, the former being adapted to the restrictions of the sculptor's chisel, the latter to the less limited technique of the scribe's brush. But the basic likeness between the forms is plainly apparent. At first sight the glyphs appear as a number of small squares rounded at the corners, representing human faces and other objects, highly conventionalised by generations of artistic usage. They have been described as " calculiform," or pebble-shaped, from the fact that the contour which encloses each of them resembles that of a small pebble. In this they are contained much as the hieroglyphs which make up the name of an Egyptian king are enclosed in a " cartouche," or oval contour. They are arranged in parallel columns, which are to be read two columns at a time, beginning with the uppermost glyph in the left-hand division. The reader must then work his way from left to right and top to bottom, ending with the lowest glyph in the second column. But should the glyphs be disposed in a horizontal band, the order of reading is from left to right, in pairs.

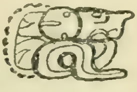
The history of the prolonged endeavour to discover the hidden meaning of these characters so obstinately dumb, although one of continuous and patient effort, is not devoid of romantic quality, and has, indeed, furnished more than one novelist with material for a tale of absorbing interest. In 1565 Landa, Bishop of Chiapas, who destroyed a large number of manuscripts on the plea that they were "the devil's picture-books," seems to have been smitten with a late compunction for his short-sighted policy, and addressed himself to the task of collecting all available information regarding the Maya writing from the native scribes who still practised it. He brought together a number of characters representing twenty-seven sounds, and the essay in which he preserved these was published by the enthusiastic but visionary Abbé Brasseur de Bourbourg at Paris in 1864, when French interest in Mexico was at its height. Landa's "alphabet" was at once hailed by Americanists as the key which would unlock the secrets of the Maya writing, the "Rosetta Stone" of America. But it was soon found that all attempts to decipher the glyphs by its agency were only partially successful, and it has been conjectured that the Indian scribes, who looked upon the bishop as the ruthless destroyer of their ancient records, purposely misled him. At the same time most of the names and symbols for the days and months as furnished by him are known to be correct, as is found by a comparison of them with the glyphs appearing in certain native books known as the Books of Chilan Balam, where they are shown with their phonetic equivalents in European letters.

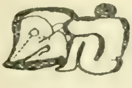

The sign which means "sun."

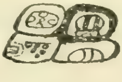

The symbol for "moon."

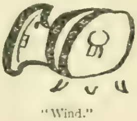

"The spring equinox."


"Feather," the sign of the plural.


The serpent symbol for "water."


Sacrificial victim.


This symbol is read, "Day of the new year in the month."


"Wind."

In 1876 the French Americanist, Leon de Rosny, published an alphabet of twenty-nine letters with numerous variants. But neither this, nor the attempt of another French savant, De Charencey, can be taken seriously. Ten years later Dr. Augustus Le Plongeon published *An Ancient Mayan Hieratic Alphabet according to Mural Inscriptions.* This, the most fantastic of the attempts to probe the mystery of the Maya symbols, compared and even identified them with those of Egypt, and did incalculable mischief in spreading the delusion that they had at last been deciphered, and were to be regarded as the prototypes of the Egyptian hieroglyphs. Most of Le Plongeon's "characters" are either ornamental details or bizarre inventions, unrepresented among the Maya glyphs.

The first student to throw any light on the manner in which the quest should be conducted if final success were to be hoped for was Professor Ernst Förstemann, of Dresden, who, about 1880, showed that the native records and inscriptions were chiefly concerned with the fixation of calendric festivals and the dating of monuments. He discovered and elucidated the elaborate and ingenious system of numeration in use among the peoples of ancient Central America, and showed how it was utilised to record astronomical and chronological facts. In short, his pioneer work made possible all subsequent progress in deciphering the texts. Curiously enough, an American student of the subject, Mr. J. T. Goodman, of Alameda, California, working independently, arrived at conclusions similar to those reached by Förstemann. Since that time the work has been carried on by the late Professor D. G. Brinton, of the University of Pennsylvania, Professor Eduard Seler, of Berlin, Mr. S. G. Morley, and, notably, by Mr. C. P. Bowditch, of Boston, who, by addressing himself to the task of placing the whole study on a systematic basis, has made it possible to survey the entire field of past endeavour and has rendered further progress practicable.

Judging from the complete state of development at which the system had arrived at the date of the discovery of Central America by the Spaniards, there is every reason to refer its origin to a past of considerable antiquity. As the late Dr. F. W. Hodges, of the Bureau of American Ethnology, remarked: "The earliest inscriptions now extant probably date from about the beginning of the Christian era, but such is the complexity of the glyphs and subject-matter, even at this early period, that, in order to estimate the age of the system, it is necessary to postulate a far greater antiquity for its origin. Indeed, all that can be safely accepted in this direction is that many centuries must have elapsed before the Maya hieroglyphic writing could have been developed to the highly complex stage where we first encounter it."

A brief examination of any Maya text reveals the presence of certain elements which occur repeatedly in the glyphs, but in varying combinations. Two or three small but separate signs frequently go to the making of each glyph. So numerous are the combinations and permutations of these, however, that the student might at first sight suppose that a great number of signs were employed in Maya writing. But closer observation will convince him that these elementary symbols are in reality few in number. His difficulty lies in identifying them and gaining experience of the different forms they take. In Egyptian texts the simple phonetic signs are unchanging under all circumstances of composition. Like the letters of our alphabet, they never vary, and may be recognised as unfailingly. But in the Maya texts the normal form of the element may be altered for reasons of space, individual peculiarities of style, or artistic symmetry. It has been ascertained, however, that each glyph holds one essential element, which was seldom altered, and that it is only in the case of accessory or supplementary elements that any great variation was permissible. But it is rare to find two glyphs which have the same meaning and the same elements precisely alike in drawing, contour, and general appearance. It is as if the letters of our alphabet were not standardised in form, but were subject to the caprice of each individual writer or printer. Such dissimilarities are often due to differences in the materials in which the glyphs are delineated, as well as to careless drawing and actual mistakes—for errors, and those not a few, have been encountered both in examples of the numeral system and the writing proper. These conditions render progress slow and results uncertain.

Sometimes the pebble-shaped outline or "cartouche" of a glyph is altered to a "head-shape"; that is, the customary form is changed to the contour of a human head. The symbols usually confined to the outline are transferred to this "head-shape," or cunningly adapted to its physiognomy in a manner which speaks volumes for the artistic ability of the Maya sculptors and scribes. These "head-variants," as they are called, are puzzling enough when the meaning of a glyph in its original form is already known. When it is unknown, they are baffling indeed.

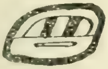
The glyphs as a whole have been divided into two groups: astronomical, calendric, and numerical signs (that is, glyphs used in counting time), and those having an explanatory function of some sort. The great majority of the symbols already deciphered belong to the first group. The second, which is much the smaller, in all probability relates the facts of Maya history.

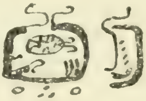
As regards the question whether the system is phonetic or pictorial in character, much difference of opinion exists. Three principal theories have been advanced to account for the nature of the Maya writing. Some authorities believe the glyphs to be phonetic, each representing a fixed sound and entirely dissociated from the presentation of any thought or idea. Others regard them as ideographic, each representing in itself some complete idea or conception, while a third school supposes them to partake of the nature of both types. It is obvious that the first theory cannot be accepted in its entirety. The glyphs unquestionably show traces of phoneticism, but all attempts to reduce them to a phonetic system or alphabet have signally failed.

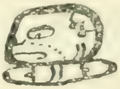
The theory that they are ideographic has a larger following. But Brinton pointed out that a native writer was able to give Landa a written character for an unfamiliar sound (as, for example, that of a Spanish letter), and that the characters the Maya scribe employed for this purpose were certainly used in the native writings. These facts led Brinton to think that some sort of phonetic writing was not unknown to the Maya; and, indeed, both the inscriptions and the manuscripts establish the soundness of this contention.

As we have seen, the phonetic sounds of certain glyphs relating to days and months are known from Landa's work, in which they are accompanied by their Maya names in European letters. In these, at least, he was not mistaken, as we glean from certain native manuscripts which record the names of the glyphs for the days and months in the same manner. One, for example, is known as yax, a picture of a tree-stump, which means "region" or "place." Another is kin, "sun," and when these symbols are combined, they are known as yaxkin, "sun-region," or "warm region"—"the south." Similarly, the character representing the phonetic value kin is also found as an element for the words likin, "east," and chikin," "west," each of which has kin as its last syllable. These elements are thus manifestly phonetic. But this notwithstanding, the glyphs alluded to have meanings quite independent of their mere phonetic values. Primarily, their function is to convey the ideas of "sun" and "region," and they were used phonetically in a secondary manner only.

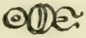
Such glyphs as are phonetic, it must be clear, rank not as letters, but as syllables. This kind of writing Brinton called ikonomatic, or rebus-writing—a script in which the characters do not indicate the meaning of the objects which they portray, but only the sounds of their names. Let us suppose, if the reader will pardon the homeliness of the illustration, that we draw pictures of a human eye, a can, a bear, a cobbler's awl, the numeral 4 and a ewe, and translate the rebus "I can bear all for you." In such a system the first picture is intended to recall not the idea "eye," but the *sound* of the word denoting the object, which is also that for the personal pronoun I. Again, the picture of a bear does not represent the idea of that animal, but stands for the sound of its name. Such a method is occasionally employed in the Maya writing, especially, thinks Mr. Bowditch, in the case of common nouns and abstract ideas. The writing in use among the Aztecs of Mexico was, indeed, entirely of this character, and it is believed that they drew inspiration from Maya sources at an early period.

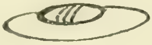

The sign for the year.

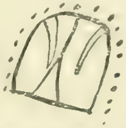

The sign for "beginning."


"The end."

The crux of the whole question, indeed, is: How far do phonetic elements enter into the composition of the Maya glyphs? It seems probable that as the decipherment of Maya writing progresses, an ever-increasing number of phonetic elements will be identified, though the idea of a glyph will always be found to overshadow its phonetic value. That is, in the consciousness of those who employed it, the system would, through generations of usage, come to possess a significance chiefly ideographic,[1] and it would not necessitate any such effort of mental translation as a people unused to rebus-writing would have to make to comprehend it readily.


"Tying together," "union."


"Division" is symbolised by a flint knife.


The sign for "night" and "sky."
The dots represent stars.

At an early stage in his researches Förstemann discovered the sign for zero or nought (a shell), which was derived from the symbol for "completeness," zero being regarded as the only complete or perfect number, incapable of division or multiplication. He was also able to show that the symbol for the moon (a cursive form of the head of the moon god), represented the Maya "month" of twenty days, the period in which the moon waxes and wanes, and therefore the number 20. It was readily found that a dot stood for the numeral one, from the analogy of the Mexican manuscripts, in which the days of the month are numbered in their proper sequence by dots, and from the same source it was gleaned that a bar or dash represented five, a bar and one dot six, two bars ten, and so forth. But the manner in which the "higher mathematics" and system of dating of the Maya were elucidated is much too involved a process to be described in a popular article, and some account of the way in which a few of the more useful glyphs were identified will, doubtless, prove of greater interest to the reader.

Förstemann recognised from Landa's work that one of the signs for a certain day of the Maya month is called akbal, which means "night," and that the sign had the same significance and phonetic value as a glyph was suggested by the star-like dots which surround it. Now akbal is used as a day-sign because it also means "the beginning of the month," the Maya month commencing immediately after midnight. Therefore, when he found the sign akbal as an element of a glyph and observed footsteps painted beneath it, Förstemann translated it as "beginning" or "forward movement." He found, too, that a glyph representing the number seven, which in Maya has the significance of "great" or "ultimate," means "the end." From the frequent contrast of these terms there can be little doubt that their significance is what he assumed it to be.

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[1] That is, each complete glyph would bear a fixed meaning.

"Union" is denoted by the sting of a rattlesnake, the coils of that reptile appearing to the Maya as symbolical of "tying together." We have here the idea of representing the whole by the part, which is also to be remarked in the glyph for "dog," which is merely a drawing of the ear of that animal. In contrast to the sign of "union" is that for "division" or "cutting," which is represented by an obsidian knife. A half-closed hand means "to eat," derived from the action by which one raises food to the mouth. Added to the kin or "sun" sign it denotes chikin, "the west," probably from the circumstance that the Maya took their principal meal at the hour of sunset. Likin, "the east," is a combination of the sun-sign kin and the symbol for "king" (ahau), which is derived from a root meaning "to rise up," "to awake," so that the whole implies "the sun awakes," "the sun rises." Xaman, the north, is more directly symbolised by the face of the devouring earth-monster, which was supposed to dwell in that region.

The figure denoting the spring equinox was traced because of its obvious representation of a cloud from which three streams of water are falling upon the earth. A square portion at the top represents the sky. The obsidian knife underneath denotes a division or period of time cut off, as it were, from other periods of the year. That the sign means "spring" is verified by its position among the other signs of the seasons.

Water is depicted by the figure of a serpent, which typifies the undulating nature of that element. The symbol known as "the sacrificial victim" is pictorially eloquent of its subject. Its first element is the vulture or death-bird, and the second shows a crouching and beaten captive, ready to be immolated to one of the terrible Maya deities whose horrid rites included human sacrifice.

The symbol signifying "the day of the new year," which occurred in the month Ceh, is composed of elements meaning "sun" or "day," "year," the sign for "division," and that for the month Ceh, the whole thus signifying "the day in which the year is separated in the month Ceh." The symbol for "wind" has also been determined from its accompaniment by a figure known to be a deity of the four cardinal points, whence all American tribes believed the wind to come.

Other glyphs identified relate to various colours, including red, yellow, white, and black, the names of certain deities and those of several planets, Venus and Mercury among them.

It is clear from what has been established that the texts are chiefly concerned with the fixation of religious festivals. But there is a residuum of matter which undoubtedly relates to historical occurrences of outstanding importance, to which the accompanying dates refer. What may these still obscure symbols not conceal? So much can be said, that what they have to disclose will make terse reading, for the signs in which the precious information is latent are few. But so highly concentrated is the syllabic script of the ingenious Maya scribes, that such of it as remains dark to us may contain more of value than we suspect.

Ocean Currents[1]

By P. J. Harwood

The present article aims to present the subject of Ocean Currents in a more definite light than has hitherto been the case. There seems at present to be no conclusive synthesis of the causes which operate to produce these phenomena, and for lack of such, we find conflicting testimonies and opinions, and, in general, inadequate and hesitating treatment, which must leave this subject in obscurity and confusion for anyone who seeks to do justice to this important branch of geographical study.

A current is dependent on the fluid nature which water possesses. It is the result of an impulse to movement where the lines of action are confined to particular portions of any body of water. Since an ocean of water is a homogeneous whole, it will follow that any disturbance made in one part will find a reaction in the remaining parts. Of all the modes of application whereby the impulse to movement can become, it is necessary to choose those which have the deeper foundations of action, and these are not necessarily those which are known and seen to have an effect disposing to the ultimate end.

A current may be produced in a variety of ways; for instance, when a pool of water is continually stirred by a stick in the same direction; when, with puffs of breath the water may be made to circulate in a basin; or, when under the action of gravity, a whirlpool is formed around the orifice of an outlet such as we see when water is emptying from a bath; and lastly, the much-referred-to convection currents, which are caused by differences of temperature in various parts of the liquid.

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[1] This article should be read with an atlas before the reader.—Ed.

Examining first the question of currents by convection, we observe :

(1) The heat of the sun is applied from above ; the surface water is therefore subject to most heat. As heated water is expanded and is therefore lightened, there will, from this cause, be no tendency for the surface water to change places with the lower water, as would be the case if the heat were applied from below. But, as against this, is the fact that ocean water contains a fair proportion of salt, which gives a Specific Gravity of, roughly, 1·027, i.e. for every 1,000 ozs. of pure water which it contains there are 27 ozs. of salt. The effect of heat in the Tropics on the salt water will be to evaporate the pure water, leaving the residuum with greater saltness. From this cause the surface water will become the heavier and, consequently, will sink. Whatever is the resultant in these two opposite cases, the motion will be vertical, and as such would bear little relation to the great horizontal currents which we are considering.

(2) There is, next, the condition of the unequal heating of the surface waters of the globe, due to the respective positions relative to the Equator and the Poles. Regarded as the primitive and sole cause for the great ocean currents, the components contained in these conditions are insufficient to account for the necessary displacements. Gravity can have no *direct* effect in drawing polar water to the Equator, and equatorial water to the Poles. And here also there arise as in (1) two complementary and opposite sets of conditions ; viz. (*a*) that cold, pure water is heavier than warm, pure water ; and (*b*) that much of the cold water of the Arctic oceans will be pure owing to the melting of glaciers and icebergs which, being frozen pure water, will, when melted, be of less specific gravity than the salt water of the oceans. This latter, (*b*), may, however, be of trifling consideration when the vast ocean waters are being considered. If the Arctic oceans are heavier than the equatorial, then the action would naturally be of a creeping or sliding—i.e. indirect—nature, the warmer water from the Equator remaining on the surface. But this creeping in folds in broad stretches from north to south and south to north, is not in accordance with the definite cyclic movement which takes place in the ocean, and therefore this influence of itself fails to account for the phenomena. Regarded, however, as a secondary influence in the operation of currents, the idea of differences of specific gravity from temperature may be considerable. For instance, if a cold current (caused by other influences) meets a warm current, there may at once be displacements in which the colder water will sink and the warmer water rise. This seems to be the case with the Gulf Stream and Labrador currents.

(3) Considering next the question of prevailing winds as causes of the ocean currents, we find here a considerable correspondence between the two, and, because wind can influence the surface flow of water, it has been inferred that the winds are the causes of the ocean currents. This, however, does not necessarily follow ; the very fact that these two fluids, the atmosphere of the earth and the water of the earth, have corresponding motions, may simply indicate that they are susceptible to the same cause or causes. The more freely moving air may then, by friction, accentuate the slower, tardier, movement of the ocean. There is, however, an example in which the action of the wind, among the factors which operate in the causation of currents, seems to be predominant. Against the normal flow we find that the north equatorial current of the Indian Ocean is changed in its direction from west to east under the influence of the Summer Monsoon. It is probable, however, that all wind action is very superficial.

The fundamental action on which all currents depend for their prime initiation can without hesitation, because of the strong evidences which arise to support it, be ascribed to the rotation of the earth. Questions of temperature, the action of winds, etc., sink into insignificance compared with the essential cause which is found in rotation. These are but modifying factors of the main factor. The rotation of the earth is the backbone of oceanic circulation.

The rotation of the earth represents a movement round a fixed axis. In this movement, the solid earth, the waters of the ocean and the gases of the atmosphere, all take part. But, whereas the solid crust of the earth is rigid and a constant relation of its parts to one another is kept up, on the other hand, the atmosphere and the oceans being fluid, movements of considerable magnitude are constantly going on within themselves, while as a whole they rotate. But also, in the actual rotation of the solid parts and the fluid parts of the earth, there is not a strict relation and fixity of action. Consider what happens if a tank of water is pushed violently away. The tank moves—the whole of it ; the water, however, slops over towards the side pushed. Relatively to the tank only, the water moves in a direction opposite to the tank. Two main factors are accountable for this. First, there is the inertia of the water which gives it a quality or tendency to remain where it was—the tank also had inertia. Secondly, it possesses the quality of fluidity wherewith, partly, its inertia can escape the effects of the push. In other words, owing to its lack of rigidity the push is not conveyed " end on " throughout the particles of the liquid. The condition of the earth is similar to this. In its rotation the waters of the ocean do not keep pace with the solid crust ; they lag behind. While, therefore, the rotation is from west to east, owing to the difference of speeds a relation arises in which, compared with the solid earth, the oceans appear to move from east to west.

It is to be noticed, further, that the surface water in the tank tends most to " slop over." This is not only because the surface water is nearest the edge of the tank, but also because it enjoys a greater freedom of movement than the under water. In the case of the under water an extra condition is imposed by the fact that it is kept down by the weight of the water above it. Thus it is *constrained* to a greater degree than the surface water, and thence it is invested with a certain rigidity or immovableness. For, acting in conjunction with the downward pressure from above is the rigidity forced upon it by the presence of the walls of the tank, which prevent its motion outwards and by resistance hold it back. In other words, the lower portion of water is *encased* by inwardly directed force pressures on all sides around. This does not occur to the same extent in the case of the surface water, which, even though the tank walls extend to a height above it, can find a freedom of movement by splashing upwards, no weight of water being above it to press it down. Applying this conception to the magnified conditions of the oceans, where in some cases the height of the waters above the floor-bed is measured in miles, the gigantic pressures which must necessarily result in the lower deeps, will confer on the liquid water an immense rigidity, and by the enormous weight above, a frictional grasp of the surface of the rigid earth crust beneath the waters, as will cause them to be rotated with the solid earth almost entire. This rigidity, as will be seen, will diminish as the free surface of the water is approached. Corresponding to the sides of the tank are the raised parts of the ocean bed rising to dry land, and it is these which keep the waters *in*, while the gently sloping shores of the land offer that minimum of resistance as would allow the extreme surface movement of the waters over them, resulting from their slipping back from the main movement of the earth. Hence, in the consideration of ocean currents, we arrive at the natural condition that such currents will be mainly *surface* currents, and will not materially extend to the great depths of the oceans. The greatest depths of ocean currents are supposed not to be more than about 1,600 feet, or, roughly, one-third of a mile.

When any homogeneous rigid body is rotated it is necessary, in order to prevent strain, for the outer layers to move at a greater speed than the inner or more central portions. Similarly, in a globe where the axis of rotation is a diameter, it is necessary for the polar layers, which are nearer to the central axis than the equatorial surface layers, to rotate at a slower speed than the latter. This occurs in the rigid body, the earth. In one rotation, a point on the Equator is carried 25,000 miles; a position in Lat. 40, 19,250 miles; at the Poles the distance of rotation becomes infinitely small. Thus, there is a graduating speed from Equator to Poles, the equatorial region being moved the fastest, viz. 25,000 ÷ 24, or 1,100 miles per hour.

According to the speed at which the solid earth and the waters above it are travelling, so the lag of inertia in the waters will have effect. At the Equator, therefore, the lag will be most pronounced, and the current there formed will be the main current of the world to which all lesser currents must subserve. If the earth is imagined entirely covered with water of uniform depth, we should then have a main ridge current round the Equator performing a continual circle of movement from east to west. On either side of this will be lesser currents. All these waters of the earth would wash round in a direction opposite to the direction of rotation of the earth, and these currents would be parallel to the Equator, and they would move at different speeds, but the resultant movement with the solid earth will be of rotation in the same direction. The lag of the currents, it might be pointed out, will, by the friction caused, tend to create a " brake action " on the earth's rotation, similar to that of the tides hypothesised by Kant; but complementary action arises to nullify this.

Looking at the map of the world, we find the ideal case above very much modified, but the intrinsic nature is not blotted out. Both in the Pacific and the Atlantic the north and south equatorial currents form the main feature. Instead of an ocean of uniform depth enveloping the earth, land masses arise between, and by their interception break up the continuous oceanic circulation above hypothesised. It is evident that the flow continues until land is approached, and, a collision taking place, the current is laterally deflected on either side, so that one branch flows north and the other south, the while continuing to exert their western tendency, as is seen by the " hugging " of the eastern shores of the continent approached. This throwing of the waters to the west is clearly seen, not only in the equatorial regions but in the regions approaching the Poles. The Labrador Current, the East Greenland Current, the Oya Siwo of East Siberia, are examples of this, though, as we shall see, the equatorial direction also enters in to cause that same hugging of the eastern shores. Thus, *Land Masses* become an important factor in the question of Ocean Currents; and though they do not originate the causes of flow, they enter as modifying agencies in disposing the final form of the complete currents.

(To be continued)

Reviews of Books

The Idea of Progress. By J. B. BURY. (Macmillan, 1920, 14*s.* net.)

It is a sign of the times that we discuss fundamentals; and of these fundamentals, the idea of progress has perhaps come in for the most searching criticism of all. We have had Bertrand Russell with his despairing yet glorious belief in the Promethean destiny of man. We have had Mr. Marvin and his band of optimistic essayists. We have had the Dean of St. Paul's, who, in his Romanes Lecture of this year, turned the doctrine of man as the cosmic rebel, so startlingly enunciated in the same building a quarter of a century ago by Huxley, into a strange blend of Christian hope and evolutionary pessimism. Now we have the most solid of recent contributions, in the shape of this volume of Professor Bury's.

The work is of the greatest value; for it is the first attempt, since the Darwinian epoch and the subsequent reaction, to give a connected and critical account of the history of the idea of progress.

So long as men were content to translate their own desires into a creed, so long as they cherished apocalyptic hopes, so long were they inevitably unable to frame an idea of progress which should not be too remote from reality. Only by a historical survey can they see what has failed, can they see why it has failed.

The most important and at the same time the most startling point here brought out is that the idea of progress as we know it, and indeed in any significant sense, was never grasped in antiquity, nor in the Middle Ages, and in fact did not germinate until the seventeenth century. The idea of progress excludes the doctrine of a Golden Age; it excludes the notion of inevitably-recurring cycles; it excludes the veneration of antiquity; it excludes belief in an immediate coming of the Kingdom of God, or, indeed, of any "illusion of finality"; it excludes real pessimism and genuine individualism; it excludes excessive "next-worldliness," as of the early Fathers. One or other of these ideas was dominant in civilised thought until the Renaissance; and it was not until the Renaissance had accomplished its work of destruction, had proceeded to construction, and had overcome its early emotions of self-complacency, that the idea of progress could be born, or at least before it could exercise any general effect upon human thought.

Dean Inge laid stress upon the progress caused by Christianity's introduction of the idea of Hope as a living force. Bury emphasises the close connection between the rise of the scientific habit of mind and of the true idea of progress. He traces it up from its genesis as a historical principle in the writings of Bodin; shows how Bacon irst coupled it with the double team of Utility and Knowedge; how the eighteenth century's optimism expanded t from a limited and verifiable principle into a universal and unverifiable dogma; how the scientific spirit began to riticise this dogma, and to search for a law of progress

[*Continued on p.* 378

T. Fisher Unwin's Books

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This volume includes contributions from, among others, Edward Clodd, Sir George Radford, A. B. Walkley, and H. B. Wheatley.

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which, like any other scientific law, should be but an epitome of observed fact; how the genius of Darwin inevitably made the question of human progress but part of a greater question, that of organic and indeed of cosmic progress; and then, in the epilogue, strangely enough, he turns to contemplate with calm the possible future dethronement of the idea of progress and its replacement by some other guiding principle.

Too high praise cannot be given to the book. The style, the range of quotation, the method and the argument, all conspire to render it invaluable to the historian, the philosopher, and the scientist, and not to be missed by the general reader. A few quotations may be allowed before we pass to criticism. The idea of progress involves advance "in a definite and desirable direction." "The principle of duty to posterity is a direct corollary of the idea of progress." "The idea of the Progress of Humanity raises a definite question of fact." "The doctrine of original sin is an insuperable obstacle to the moral amelioration of the race by any gradual process of development." " . . . For Comte, the coming society which he adumbrated was the final state of humanity." We would quote more, but space is limited.

The only important criticism to be passed upon the volume is that its author, in common with the Dean of St. Paul's, Bertrand Russell, and indeed most modern thinkers on the subject, pays no adequate attention to biological progress. This must be a corner-stone in any doctrine of progress; and its neglect can only be explained if we suppose that the biologist's reaction against evolutionary speculation still dominates lay speculation, and that the recent more hopeful and more constructive work has not yet percolated through to the lay mind.

It is impossible to discuss the matter here. We must be content with reminding our readers of one fact—namely that if Evolution be a reality, man has been produced from unicellular organisms. This is a change in a "definite and desirable direction"; and the majority of, though not by any means all, evolutionary changes are in the same direction. It is common knowledge that all direction in evolution has not been upward; there has been degeneration, parasitism, over-specialisation. But the upper level attained by evolving life has steadily risen. Life as a whole has moved in a progressive direction—towards greater control of the external world, towards greater independence, towards greater internal harmony, and towards greater intensity of emotion. Not only this; but such changes have occurred in several separate evolutionary lines, and would have occurred even if man had never arisen.

Through biology, we are not only given the assurance that real progress has occurred, but are enabled to see what its type has been. Biological progress, real but imperfect, is a touchstone for the theories of human progress. The last step in evolutionary progress has been that man, himself a product of that process, has become aware of it. The next step will be that (if he choose to exert himself) he will, deliberately and of set purpose, bend himself to control, to refine, and to accelerate it.

J. S. Huxley.

Mental Tests in the American Army. Compiled and edited by C. S. Yoakum and R. M. Yerkes. (Sidgwick & Jackson, London, 6*s*. 6*d*.)

This is an important book primarily for psychologists and educationists, but also of great interest to everyone interested in examinations, more particularly those which go by the name of mental tests, and to the important deductions respecting the mentality of those examined which may be made. It deals, of course, with Americans and with an army that is past, but it would be a great mistake to neglect the book for these reasons. It is full of intellectual interest; it is also what one might describe as a very human book.

This book deals with a very important experiment. The Americans came into the war later than we did, and while we were busy in holding our own, they had time to think and to look round. They hit upon the idea of classifying their personnel in the army by mental tests, so that they might have at least some guide in placing their officers and men in the different units. We, on the other hand, had University professors frying bacon as mess-cooks merely because their spectacles prevented their being in the trenches, and, in many cases, a man with little more than the brain of a louse taking charge of highly technical and administrative work merely because he was of such-and-such a rank at the outbreak of war. Occasionally, and oftener towards the end of the war, the man and the job suited each other, and he could get ahead with his work unmolested by some dead-beat who happened to be a week senior in rank, or by unqualified assistants who had wandered in from nowhere.

The Americans had a better chance than ourselves to classify men. They were under no illusions that brains or cleverness, or whatever it is that was revealed by the mental tests, were the only things necessary to make the efficient soldier. But it was a very good way of sizing up people pending further inquiries, and there is no question that this method of classification was a success. The subject has already been discussed in Discovery by Dr. Veazie.

This book gives a full description of the work of the men who organised the mental tests, carried out the examinations, and made the classifications and deductions from the results. The examination tests themselves are given in full detail, with a description of the conditions under which those examined were tested. The tests were of a very varied nature, designed to test intelligence, common sense, and resource rather than knowledge of facts; but we, who are not being examined, can see their human and at times their humorous side. A few only will strike English readers as being very American. Devotees of parlour games, lovers of guessing competitions and conundrums, will find abundant material here to make them happy.

Altogether a most illuminating and at the same time enjoyable book.

Handbook of Patent Law of All Countries. By W. P. Thompson. (Stevens & Sons, 6*s*.)

This is the eighteenth edition of a book that appeared originally fifteen years before the present writer was born. Mr. Thompson has been a patent agent in Liverpool even longer than that. It is deduced, therefore, that the author knows very well what he is writing about, and the reviewer confirms this view. This book is the best synopsis of British Patent Law that has appeared. It tells anyone who wishes to take out a patent the best way in which he can secure one, not only in this country, but also (and this is often of great importance) in other countries. Much sound wisdom on the best kind of things to secure patents in and guidance on investing in patents is given, and the description of the large sums of money to be made from patents almost tempts one to give up reviewing for inventing. It seems so easy, and doubtless at times it is. The law is expounded for nearly all the countries in the world which have issued patent ordinances. The book is a valuable and trustworthy guide.

The Year Book of the Universities of the Empire, 1918–1920. Edited by W. H. Dawson. (G. Bell & Sons, 15*s*. net.)

The new edition of this year-book, which has recently appeared, has brought the Third Edition (1916) right up to date, and careful examination and a frequent consultation of it have left the reviewer with no other opinion than that Mr. W. H. Dawson, who has edited this book, and the Committee of the Universities Bureau, who are responsible for its publication, are to be congratulated upon their work. It will find a place in all public libraries, and on the writing-table of the common-rooms of our colleges and universities, and, we hope, in the private possession of university men and of many of those who are interested in the universities of the Empire, their doings and their staffs.

What is this Year-Book? It is a conspectus (a good word!) of the calendars of all British universities both abroad and at home. It gives a condensed but authoritative version of the principal facts about universities—their courses, examinations, degrees; their buildings, laboratories, libraries; the numbers of their students, etc. It gives complete lists also of the teaching and administrative staffs, which, considering the difficulties in front of the compiler, reflect great credit upon his diligence and his skill. They are remarkably accurate. A book in which all the really important facts are either given wrongly or omitted altogether is always irritating; and that is why all but a few of the best reference books are suspect. It is even unpleasant to have one's own name or initials given wrongly in reference books. We are glad that care has made this book so accurate. There are one or two slight omissions to which we may call attention. The McCrea-Magee college in Derry, which is affiliated to Trinity College, Dublin, is not mentioned. Also all the Munros but one are referred to in the index as Mungo. Doubtless the printer was a Glasgow man! Of the men known to the reviewer whose names might have been included in the book, two alone are missing. One of these was appointed to Hong-Kong University, and the other moves so rapidly from university to university that, doubtless, he was in the train when the lists were compiled, and, like the hare in the story of the

[*Continued on p. 380*

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Harvard man and the sheep in the pen, was moving too quickly to be conveniently counted.

In the Empire at the present time there are nearly sixty properly-constituted universities. Nineteen of these are in Canada, nine in India, six in Australia, three in South Africa, and one each in New Zealand, Malta, and Hong-Kong. At home there are eighteen, excluding the unattached University Colleges: three being in Ireland, four in Scotland, and eleven in England and Wales. The days when Society and the fashionable press could admit the existence of Oxford, Cambridge, and Trinity College, Dublin, only are now happily over for ever. Most of the home universities of to-day are better in every way than were these fifty years ago—more alive, better equipped, more scientific in spirit, more humane in outlook. One may safely divide the eighteen by two, and talk now of the first nine universities of this country instead of the first (or only) three of 1870.

The university man will find the lists of professors and lecturers at the different universities the most frequently consulted part of the book. If not a Who's Who, it is at least a Who's Where of the brotherhood. It is hoped that the demand for this book may make possible a new edition annually, so that these valuable lists may be kept as up-to-date as possible.

A special feature of the present edition is the appendix, giving an account of war activities other than combatant which the home universities did. "So numerous and varied have these been, that it is impossible in looking back to picture the war as progressing towards a successful issue without them." An account is given also of the contribution to the forces of the universities overseas. A really excellent handbook. P. K. F.

Meteorology. By R. G. K. LEMPFERT, M.A., C.B.E. (Methuen & Co., 7s. 6d. net.)

One surmises that, in addition to those who owe an initial acquaintance with the broad principles of modern meteorology to the perusal of Mr. Lempfert's *Weather Science* (a brief but admirably clear outline of the subject), many who are naturally curious concerning the processes operating in the earth's atmosphere and manifesting themselves in weather phenomena will welcome this, the author's latest work.

Details of observational routine have been almost entirely omitted, and the author has concentrated upon a presentation of the main facts which have emerged, especially during the past two decades, as the consequence of organised exploration of the atmosphere by means of kites and balloons carrying autographic instruments. The information thus rendered available has effected a rapid, yet sound, development of the conceptions of atmospheric structure and circulation.

The early chapters are devoted to a consideration of the Weather Map (an increasingly powerful instrument in the hands of the forecaster in these days of radio-communication), an adequate treatment of wind, pressure, temperature, and the relation of wind to the distribution of pressure, a relation upon which depends so much of the superstructure of meteorological theory.

A discussion of the ascertained behaviour of surface air currents and a study of "line squalls" (those abrupt phenomena so disconcerting, even if not fraught with actual peril, to aircraft) conclude with a description of the thought-provoking views on the structure of moving cyclones advanced last year by Bjerknes, who, extending the scope of his original investigation, has formed the opinion that at least in temperate latitudes great weather changes are due to the interaction in a definite way between phalanxes of air from polar and equatorial regions.

But we feel that it is the latter half of the volume which will appeal most powerfully to those who are desirous of acquiring an insight into the present state of knowledge concerning parts of the earth's atmosphere which in recent years have become accessible to aviators, and, observationally, to meteorologists, by means of pilot and registering balloons.

The thermal processes of the atmosphere, the variation of wind with height, the relations between atmospheric circulation, temperature, and pressure in the upper levels, are dealt with in an illuminating way; while the author's exposition of the facts and theories concerning the stratosphere (the mysterious upper portion of the atmosphere), the deeper differences between anticyclones and cyclones, and the domination of the surface conditions by those which obtain at a certain high level, cannot fail to fascinate the reader.

The value of the book is enhanced by the incorporation of accounts of the most recent work in various branches of the subject. In addition to the investigation of Bjerknes, mention is made of G. I. Taylor's important theory of eddy-motion, with its several applications to phenomena associated with the surface layers of the atmosphere; and of the lately published determination of atmospheric composition at great heights by S. Chapman and E. A. Milne, who conclude that at heights above seventy-five miles the chief constituent is probably helium and not hydrogen, as has been usually believed.

There is frequent mention of the mutual relation and interaction between the war and meteorology. As a case in point, the author, after demonstrating how, from a knowledge of wind direction and speed in the upper levels, the distribution of pressure and temperature may be inferred, proceeds to deduce the conditions which gave rise to the unexpectedly strong northerly winds at heights above 10,000 feet on October 19, 1917, an occasion which proved catastrophic to a fleet of Zeppelin airships, which, after raiding S.E. England, was carried far to the south and scattered over France.

Whilst remembering that a work on meteorology must be inevitably of somewhat limited scope if it is to be kept within moderate dimensions, one has to confess to some slight disappointment that it was considered impossible or inadvisable to incorporate in the volume under notice a fuller treatment of physical processes associated with the formation of the various cloud forms, the interesting but complicated phenomena of thunderstorms, and, finally, a presentation of the information at present available concerning the influence of solar activity upon the processes of the earth's atmosphere.

In comparison with some others, for example Germany, this country has been singularly lacking in meteorological books written by persons of authority, and for this reason, if for no other, one is glad to receive a work by an Assistant Director of the Meteorological Office.

This luminously expressed and, one may add, well-produced statement of the chief features of modern meteorological endeavour and thought requires no profound knowledge of mathematics or physics on the part of the reader, and will be of inestimable value to those who cannot readily gain access to official and other publications containing the detailed accounts of original investigations. Not less irresistibly will the book appeal to those who contemplate adopting, or who have recently adopted, the profession of meteorology, and, lastly, to all students of science, particularly of physics and mathematics, whose attention is normally not directed during a university career to the manifold problems of the atmosphere which await investigation and elucidation.

H. W. L. ABSALOM.

Studies in Fossil Botany. By D. H. SCOTT, D.Sc., F.R.S. Third Edition. Vol. I, Pteridophyta. (A. & C. Black, 1920, 25*s.* net.)

Dr. Scott's volumes on Fossil Botany are sufficiently well known to the botanical student as affording the readiest and clearest introduction to this branch of the science, and the fact that they hold the field is shown by the issue of successively enlarged editions. The work was originally published in one volume (1900), and increased to two volumes in 1908. The first part of the latter issue has now grown from 363 pages to 434, with an added selection of 66 new figures, or 190 in all. The earlier chapters follow the previous editions with comparatively little modification, including accounts of Equisetales, Sphenophyllales, and Lycopodiales of the Coal Measures, as derived more particularly from the examination of sections of coal-balls, in which details of anatomical structure are so clearly shown that one acquires a conception of the general organisation of these remarkable plants, almost as complete as if they were still alive. Many of these arborescent Calamites and Lepidodendra attained forest dimensions as 100-feet trees, and they are still visualised by the help of their diminutive modern representatives as Horse-tails and Club-mosses; but even in the distant ages at which their remains culminate in the English Coal Measures, they were as highly organised and as widely divergent as are their reduced descendants at the present day; hence, their origin may be antedated by many geological epochs. Though slight suggestions of attempts at the seed-habit may be traced in some Lycopodiales, and other families of fern-like habit have been more successful in this direction, the true Ferns of the Palæozoic are comparatively few, and they are represented by equally divergent and peculiar forms as Botryopterids and Zygopterids, the anatomy of whose stems affords as pleasing a study as that of Mesozoic

Continued on p.382

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Osmundaceæ. In all such fossil series the marvel grows that these types of vegetation, often so well characterised in xeromorphic organisation, should have been so remarkably constant in general morphology back to remote Palæozoic times, with as little suggestion as to the evolution of their own very special lines as of those of any other type of plant. For the causes that produced them one must go far back beyond the Carboniferous; and while the vegetation of this period is made up of types evidently already relegated to inferior biological stations, as partial aquatics or the vegetation of swamps liable to marine inundations, there is little suggestion as to what may have been the plant-life growing contemporaneously in forest-formation on better ground, of which no trace appears to have been fossilised. The extent to which fossil botany can ever have anything to say on the question of origins receives emphasis, as the appearance of a type in the fossil state clearly affords little clue to either the locus or the time of its initiation, and palæobotanists are still prone to confuse " first appearance " with " evolution." Thus, Dr. Scott writes (p. 370) : " A remarkable lacuna in our knowledge of the older fossil Filicales is the entire absence, so far as is yet ascertained, of any satisfactory evidence for the existence of heterosporous forms." Yet in other series the seed-habit, as following on beyond the heterosporous condition, was already well advanced in trees of the Upper Devonian, as well as in Carboniferous Pteridosperms. The period for the first inception of Heterospory must be very remote, as it is difficult to believe that such a significant adaptation to subaerial environment was not contemporaneous in all advancing phyla of Land-flora, and that modern Heterosporous Filicineæ must be a mere relic of the many types that have been, whether these are found in the fossil state or not.

A final section, which is entirely new, will be welcomed by botanists as affording a useful summary of recent publications by Kidston and Lang on the critical types of *Rhynia* and *Hornea*, which have been attributed, without any very clear reasons, to Psilophytales, on the lines of Dawson's older genus of *Psilophyton* (1859). These plants are classed by Dr. Scott with Pteridophyta, on the assumption that the definition of the latter must include any form in which the sporophyte generation is a plant apparently wholly independent of the gametophyte and attached to the soil, however little it may resemble a Pteridophyte in other fundamental features. The plants were growing on peat, presumably formed by their ultimate decomposition, and have been found in the Lower Devonian of Scotland. They are very suggestive of an enlarged moss-habit, only the branches bear spore-capsules, including spore-tetrads, which belong distinctly to the asexual generation. Any light that can be thrown on the vexed question of the extreme dissimilarity of the two generations of the moss life-cycle should be welcome, in view of the fact that the Bryophyta represent the simplest and presumably the most archaic forms of land-flora, and may hence be expected to illustrate more clearly than any other types the biological factors which have led to the successful evolution of land-plants. From the general consideration of the modern representatives of these series, it would appear that the two generations were originally of identical morphological organisation, inheriting a two-phase life-cycle from the higher algæ of the sea ; and that while the moss-capsule has been adjusted to the production and dispersal of air-borne spores, its increasing parasitism on the parental gametophyte generation has led to a state of decadence and somatic deterioration as a self-supporting organism, as illustrated in further degree by the smaller and more wholly parasitic capsules of Hepaticæ and Jungermanniæ. That the modern moss-sporogonium is but a relic of a shoot-system which was once branched and probably leafy, with photosynthetic tissues and stomata, bearing spore-producing end-ramuli in the manner of the antheridial ramuli of the leafy moss-plant, may be accepted, in spite of much older academic speculation to the contrary. The general organisation of *Rhynia* and *Hornea* so closely approximates that of such an ideal prototype, in their freely branched rhizome-system with vestigial leaf-points, terminal capsules, and rhizoidal attachment to the peaty soil, that these and associated types bid fair to be the most critically valuable forms of plant described in recent years since the original accounts of *Bennettites* and *Lyginodendron*.

The fact that Dr. Scott, following Kidston and Lang, homologises these peat-plants with the saprophytic *Psilotum* of tropical forests as primitive Pteridophytes, in which progressive sterilisation has not yet given rise to definite leaf-members, and a root-system is not yet invented, as an emendation on the admiration expressed for *Lycopodium Selago* in the " Land Flora " of Professor Bower, admirably illustrates how plastic are the interpretations of such incipient land-flora, and the connection of these ancient lines of moss and fern descent. But it may be pointed out that the discussion of these problems is by no means a question of minor significance to be relegated to the botanical specialist alone. The story of the first evolution of land-plants, even if regarded from no higher an outlook than that of the preparation of the earth's surface for the human race, is one that should interest all representatives of the latter who, in spite of more poetical ways of putting it, are still dependent on subaerial vegetation for their daily bread.

A. H. C.

Elementary Notes on Conifers. By A. H. CHURCH, *Oxford Botanical Memoirs*, No. 8. (Oxford University Press, 2s. net.)

No. 8 of this useful series, issued by the Oxford Botanical Department, comprises a further instalment of Lecture and Laboratory schedules, arranged more particularly for a class of Forestry students, and represents the continuation of a first-year course of botany outlined in preceding memoirs. The schedules are admittedly extremely technical in nature and are full of detail, though abstracted and compressed to a point at which they may be unintelligible to the lay mind without considerable oral explanation. They are perhaps more interesting as exemplifying what may be not a wholly new departure in university teaching, in which, with the spread of modern textbooks, mere mechanical note-taking has become an anachronism. In such a subject as Botany, however, in which elementary textbooks covering this class of work are scanty, and the phraseology alone is often a deterrent, such schedules giving a minimum of accurate information form an admirable basis for a lecture which may be made interesting to both lecturer and students. The idea is worthy of more extended application. Not only is a considerable amount of information packed away in the two pages of text of some sixty lines each for each schedule, but the collected series affords a good idea of the scope of the subject. The present series contains a fairly detailed account of the organisation of the Scots Pine, in timber, foliage-leaf, and reproductive processes, together with shorter summaries for other types of associated Coniferous forest-trees, as spread over a course of fifteen lectures.

Form-Factors in Coniferæ. By A. H. CHURCH, *Oxford Botanical Memoirs*, No. 9. (Oxford University Press, 2s. net.)

No. 9 follows slightly different lines, but is arranged as supplementary to the bare lecture-notes. Attention is drawn more particularly to the value of features of external morphology of the same series of Coniferous trees, from the standpoint of racial organisation and evolutionary progression. The more theoretical relations of genera and species are at the present day largely discussed in terms of the more minute microscopic detail of timber-anatomy, and the cytological specialisation of the reproductive processes and sexual prothallia. It is interesting to find that so much can be made of the more readily observed broader features of the organisation of these plants, as examined in the open rather than in the laboratory, and thus coming within the range of the field-botanist. The expression "form-factor" is utilised to cover features of construction, as opposed to its more technical application in determining the amount of available timber, and includes such subjects as the different phases of dorsiventral habit in lateral branches, the shapes of cones, the mechanism of seed-protection and dispersal, as well as throwing new light on the general theory of the origin of the curious xeromorphic construction known as the "Pine-cone." Final sections include suggestions as to the past history of the genera in geological time, and a useful summary of the distribution and significance of "monstrosities."

The subject is again largely technical, and is written out in an aggressively botanical manner; but to those who will take the trouble to master the somewhat abstruse and condensed phraseology, the pages afford a welcome introduction to some of the more striking problems of the life-history of these few residual survivors of an older epoch of forest-vegetation, and one may begin to take a new and personal interest in such tree-types as living organisms with their own ideals and limitations.

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Editorial Notes

A happy period spent recently in bed gave me an opportunity of rereading some of Dickens, and led me to the fascinating and interesting problem of Edwin Drood. This problem is an excellent one to study during an illness, not only because it takes one's mind away from the happenings of to-day, but also because its solution does not involve anything that is vital. However the various problems of the story may be solved, no one—not even the author of the story—is one penny the worse. The problem of Edwin Drood exists, of course, because this last novel of Dickens has barely half been told, and because Dickens built up his stories according to a system on which conjectures may be based regarding the possible development and end of the story.

* * * * *

The problems in the story are these:

(1) Was Edwin Drood murdered? Is so, how, by whom, and where was his body hidden?

(2) Who was Datchery, the stranger who appeared in Cloisterham after Drood's disappearance?

(3) Who was the old opium woman called the Princess Puffer, and why did she pursue Jasper? The last of these is not of great interest, and as the materials available for its solution are scanty, it has been dropped by most people. Not so, however, the others.

It was Mr. R. A. Proctor, the astronomer, who started the serious discussion on these problems. He put forward a view that Drood was not murdered, but rescued by Durdles from the bed of quicklime, and that he appeared later in the story disguised as Datchery. Among the chief of those who have contributed to the discussion have been Mr. Cuming Walters, Dr. M. R. James, Prof. Henry Jackson, and Sir W. Robertson Nicoll. The general opinion now is that Jasper would have murdered Drood by strangling him with his neckerchief and casting the body into lime. The gold ring on Drood's hand would have escaped decomposition, and would ultimately reveal the murderer. This was the little fact that the story-book murderer, for all his cleverness, was going to overlook. Sir W. R. Nicoll, whose book[1] on the subject is perhaps the best, accepts this view, and the latest book,[2] that by Mr. Carden (published at the end of 1920), concurs.

* * * * *

The question, "Who was Datchery?" is a much harder one. If one assumes, as nearly all students of the problem do, that Datchery is someone in disguise and someone who has already appeared in the book, the choice narrows itself to Bazzard, the clerk of Old Grewgious; Tartar, the seafaring man whose job was to look after Neville; and curiously enough Helena Landless. Bazzard seems the obvious solution to any reader who forgets that an author is nearly always cleverer than all but the acutest of his readers. Tartar is another solution; it has been ably advocated by Mr. Gadd, and Mr. Carden adopts this solution in his book. The majority, and notably Mr. Cuming Walters, and later Sir W. R. Nicoll, believe that Datchery was really Helena Landless cleverly disguised. She had the necessary qualifications. Her whole heart was in the affair for which the disguise was necessary. The fact that Datchery concealed his hands on nearly every occasion suggests that he was a woman. It is a pity that we shall never know the truth.

---

[1] *The Problem of Edwin Drood.* A Study in the Methods of Dickens. (Hodder & Stoughton, 4*s*. 6*d*.)

[2] *The Murder of Edwin Drood.* By Percy T. Carden. (Palmer, 6*s*. net.)

Surnames and the Chronology of the English Vocabulary

By Professor Ernest Weekley and Miss Dorothy D. Pilkington, M.A.

To students of the English language the date of first appearance of such words as are not already recorded in Anglo-Saxon is a matter of considerable interest. The great authority in this matter of chronology is, of course, the New English Dictionary.[1] But this monumental work has made hardly any use of one of the most valuable sources of information, viz. the surnames of our ancestors recorded in the Government Rolls and in innumerable local documents such as Abbey cartularies, Borough records, Manor Court rolls, etc., of which great numbers have been published by various antiquarian societies. Surnames are now felt to be proper nouns which have no place in a dictionary; but this only applies really to patronymics (Edwards, Johnson, Dicks, etc.), or to those taken from the names of towns and villages (Bedford, Chichester, Bingham, Woodley, etc.). All other surnames originated as descriptions (Arrowsmith, Baker, Good, Bullock, Partridge, Armstrong, Sheepshanks, Shakespear, Doolittle, Truelove, etc.) or addresses (Field, Wood, Athill, Bytheway, etc.), and are formed from the everyday colloquial language. If, then, we find the name of Alan le arwesmyth in the Close Rolls for 1288–96, we may conclude that the first N.E.D. record for *c.* 1400 must be at least one century, and probably two or three centuries, too late, as the compound would not be likely to be used as a description or means of identification unless it were a well-understood word of long standing. It is sufficiently clear that any word in general use as a surname must have had a pretty long previous existence in the language.

In this article only one group of surnames is considered, viz. the interesting class of nicknames of compound form. Such names may be (1) descriptive of occupation, e.g. Bridgman, Cartwright; (2) names of wares which the bearer made or sold, e.g. Horsnail, Whitbread; (3) verbal phrases descriptive of trade, habit, habitual gesture, etc., e.g. Boughtflower (= bolt, i.e. sift, flour), Wagstaff; (4) physical nicknames, e.g. Broadhead, Lightfoot; (5) descriptive of dress or equipment, e.g. Curthose, Longstaff; (6) animal nicknames, e.g. Duncalf, Woodcock; (7) descriptive of characters, e.g. Gentleman, Merryweather; (8) from abstract qualities, e.g. Fairservice, Truelove. There are also a great many miscellaneous compounds which do not fit into this, necessarily rather rough, classification, such as names derived from the vegetable world, e.g. Peascod, Sweetapple, from coins and money, e.g. Halpenny, Hallmark (for half-mark), and from oaths and exclamations, e.g. Pardew (par Dieu), Godbehere. How such names were acquired is not a question which can be dealt with here. Those which survive as existing surnames are only a very small proportion, but there are enough of them to give some idea of the extraordinary and fantastic character of Middle English nomenclature. On the other hand, a very large number of compounds which now exist as common nouns only are found as mediæval nicknames, and very often, as we shall see, at dates long anterior to the earliest records established by the N.E.D.

I will now quote a few examples from the various classes of compounds, giving the date at which each is found as a surname compared with the date of the first record given by the N.E.D. of the same word as a common noun. The material I have before me[2] contains a list of nearly 250 examples which antedate the N.E.D. by one century at least, and sometimes by more than four centuries, besides some thousands of compounds of which dictionaries show no record. It should be premised that the great mass of English surnames were the creation of the twelfth and thirteenth centuries (the Anglo-Saxon had usually a single name), and began to become hereditary and fixed from the fourteenth century onward. Hence, as a general rule, we may assume that any word now well established as a surname must have been current in English not very long after the Conquest. This may be illustrated by such a name as Crabtree, common in the West Riding of Yorkshire. The N.E.D. records *crab* (apple) *c.* 1420, and *crabtree c.* 1425; but the existence of the latter as a mediæval surname suggests that both the compound and the simplex must have been familiar words at least a century earlier. This name is also an example of the impossibility of "explaining" surnames. Did the first Crabtree obtain his name from the tree near which he lived (cf. Ash, Thorne, or Nash, i.e. *atten ash*, Noakes, i.e. *atten oaks*), from his "vinegar aspect" (cf. Sweetapple), or from habitually carrying a crabtree staff (cf. Hardstaff)? It is impossible to say which, if any, of these explanations is the true one. The same applies to many of the names dealt with in this article. What appears to be an occupative surname may have been originally a nickname given for reasons now unknown, and mediæval sobriquets were no doubt often ironical, so that Makepeace may have been cantankerous, Drinkwater a wine-bibber, Snowball a swarthy man, and Fairweather a grouser. As the N.E.D. has not yet got beyond V, no comparison is possible for the rather numerous compound names in W. For these Stratmann and Bradley's Middle English Dictionary may be consulted. This contains, for instance, no record of *wainwright*, though, judging from its frequent occurrence as a surname, it must have been current English by *c.* 1300 at the latest. In fact it is well attested as a surname from about that date.

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[1] Referred to in the article as N.E.D. A short account of the New English Dictionary appeared in DISCOVERY for July 1920, p. 196.

[2] This material consists of a thesis for which Miss Dorothy Pilkington was awarded in 1920 the M.A. degree of the University of London. The character of the investigation was suggested by me, and I also indicated to Miss Pilkington the chief sources of which she could make use. The results she has obtained seem to me of considerable value for the historical study of our language.

The following are some of the most striking examples of occupative names taken from Miss Pilkington's lists:

N.E.D. Record.		Surname Record.
ale-brewer	*c.* 1510	Cristin le alebrewere (City Letter-books, 1307–27).
anchor-smith	1662	Benedict ankersmith (Norwich Records, 1355)
bell-founder	1530	Michael the bellfounder (Close Rolls, 1318–23).
blacksmith [1]	1483	William blakesmyth (Patent Rolls, 1266–72).
boatman	1513	Gervase the boteman (Patent Rolls, 1313–17).
candle-maker	1611	Theophilus the kandilmaker (Patent Rolls, 1317–21).
cellarman	1658	Walter le celeresman (Coram Rege Rolls, 1297).
charwoman	1596	Alice charwoman (Nottingham Records, 1379).
cheesemonger	*c.* 1510	Baldwin le chesemangere (Pipe Rolls, 1185–6).
coxswain	1463	John cokeswayne (Patent Rolls, 1327–30).
cornmonger	*c.* 1515	Peter le cormangere (Pipe Rolls, 1176–7).
cowkeeper	1680	David le cowkeeper (Vale Royal Abbey, 1330).
ferryman	1464	Richard le feriman (Lanc. Assize Rolls, 1246–7).
fisherman	1526	Silvester the fisherman (Close Rolls, 1327–30).
fishmonger	1464	Lawrence le fysshmongere (Close Rolls, 1307–13).
foxhunter	1692	William le foxhunte (Patent Rolls, 1258–66).
goldbeater	1415	Robert le goldbeter (Hundred Rolls, 1273).
horse-merchant	1711	Theobald the horsemerchant (Close Rolls, 1272–9).
hunt(s)man	1567	Walter hunteman (Hundred Rolls, 1273).
knifesmith	1738	Adam knyfesmith (Lanc. Assize Rolls, 1285).
shearsmith	1623–4	Geoffrey sheresmyth (Freemen of York, 1391).
stone-hewer	1579–80	John the stoneheware (Gloucester Records, *c.* 1230).

In addition to the above selection may be mentioned a large number of compounds of *-man* (inkman, mailman, leatherman, oysterman, etc)., *-monger* (buttermonger, feathermonger, flaxmonger, horsemonger, etc.), *-wright* (glasswright, basketwright, kitwright, tilewright, etc.), mostly recorded as surnames some centuries earlier than the N.E.D. There are also some archaic titles of interest to the historian and the antiquary. The N.E.D. defines the obsolete *borsholder* (recorded 1536) as "the chief of a tithing or frankpledge; afterwards a parish officer identical in functions with the Petty Constable." Thomas le borewesaldre is in the Charter Rolls for 1257–1300. *Frankpledge* is found in Anglo-French form in Britton (1292). The first English record is 1495, and the sense of "one of the mutually responsible members of a tithing" is not found by the N.E.D. till 1502. But Robert le francpledge occurs in 1237 in Archbishop Gray's Register. Even *hayward*, the parish official responsible for fences, etc., recorded by the N.E.D. from the Ancren Riwle (early thirteenth century), is taken a little further back by Miss Pilkington, who has found Ricardus heiward in the Pipe Rolls for 1165–6. Occasionally a name of this type points to the earlier existence of a simplex, e.g. the name of Robert le mittenmaker in Norwich Records, 1288, shows that *mitten* must be considerably older than the N.E.D. record, *c.* 1386.

Surnames taken from names of commodities are not necessarily of occupative origin, but there are strong reasons for believing that this is often the case, e.g. that Hogsflesh was the nickname of a pork-butcher, Horsnail of a farrier, Whitbread of a baker, etc. Examples of compounds of this kind are—

N.E.D. Record		Surname Record.
barley bread	*c.* 1320	Josce barlibred (Pipe Rolls, 1184–5).
blanc-mange	1377	Stephen blangmong (Hundred Rolls, 1273)
butter-kit (= cask)	1507	Robert buktreyde (*ibid.*).
bread-and-cheese	1550	Robert chesandbred (Patent Rolls, 1330–4).
codfish	1565–73	Thomas cotfich (Hundred Rolls, 1273).
hard-fish (= dried)	1808	Richard hardfyssh (Feudal Aids, 1401–2).
honeypot	1483	John hunypot (Patent Rolls, 1313–17).
horse-nail	1508	William horsnail (Close Rolls, 1234–7).
rye-bread	1507	Adam rybred (Charter Rolls, 1300–26).
small-ware	1617	Robert smalware (Pipe Rolls, 1184–5).

The most picturesque type of compound surname is that formed from a verb accompanied by a noun or an adverb, e.g. Shake-spear, Go-lightly. Here the comparison with dictionary dates can only be made occasionally, as few of these compounds appear to have got recorded as common nouns, though they swarm in the Middle Ages as surnames, not only in England, but in Continental countries. The list before me includes about a thousand of this class. Here are a few which are registered by the N.E.D. as occurring in (mostly archaic) language :

---

[1] This may refer to the smith's complexion (cf. the name Brownsmith).

N.E.D. Record.		Surname Record.
drinkwater	1641	John drinkwater (Hundred Rolls, 1273).
lickdish (= parasite)	1440	Leofric likedich (Ramsey Cartulary, 1114–16).
makepeace	1510	Gregory makepais (Leicester Records, 1210).
picklock	1553	Thomas pyclok (Patent Rolls, 1338–40).
rattlebag	1728	John ratellebagge (Hundred Rolls, 1273).
scattergood (= prodigal)	1577	Robert scatergod (Cockersand Cartulary, 1200–26).
sparegood (= miser)	1611	Walter sparegod (Hundred Rolls, 1273).
spillcause (= marplot)	1566	Alexander spillecause (*ibid.*).

Sometimes a surname of this type throws light on the antiquity of a verb, e.g. the N.E.D. does not record the verb *to drain* till 1538, but Simon draneland lived in the Cambridgeshire fens in 1273 (Hundred Rolls). The colloquial verb *to lump* (like it or lump it) is recorded for 1577, but Matilda lumppejoye, apparently the opposite of the existing Lovejoy, is in the Patent Rolls for 1307–13. The N.E.D. has (1586) the odd compound *break-dance* in the sense of turbulent. William brekedaunce is in the Patent Rolls for 1330–4. The phrase "to turn a penny" is first recorded for 1546, but Matilda tornepeni is in the Hundred Rolls, 1273. The name of Nicholas turncotel in the Ramsey Cartulary, 1252, where *cotel* is an old diminutive form of *coat*, suggests that *turncoat* itself must be older than the N.E.D. record of 1557. The phrase "to drink at pin," referring to the pegs which marked the measures in large tankards, is not found earlier than 1655. William drinkepin is in the Ramsey Cartulary, 1206. Even *farewell*, as the surname of Robert farewel (Close Rolls, 1242–7), is more than a century earlier than the N.E.D. record (1374).

In the list before me are fifty-five compounds of *-head*, some of which, e.g. Broadhead, Whitehead, are still fairly common. Few of these are in the N.E.D., though many of the corresponding adjectives are recorded, e.g. broad-headed (1530), with which cf. Emma brodhevid (Durham Eyre Rolls, 1243). It is curious to compare the modern *fathead* (N.E.D. 1842) with John ffathevit (Cockersand Cartulary, 1220). Redhead is common as a surname from the thirteenth century, though not recorded by the N.E.D. till 1664, and Adam rudipat (Fines Rolls, 1199–1216) is a century earlier than the first hitherto known occurrence of the simple *pate* (*c.* 1305). *Armful* is not given, in any sense, by the N.E.D. till 1579. Adam fayrarmful is in the Lanc. Assize Rolls for 1246–7. *Body*, in the sense of person (cf. *busybody*), dates from 1279. Eustace frebodi is in the Leicester Records for 1206–7. Corresponding to the adjectives *leather-mouthed* (N.E.D. 1653), *sweet-mouthed* (*ibid.*, 1611), *fair-haired* (*ibid.*, 1626), *long-legged* (*ibid.*, 1590), *good-hearted* (*ibid.*, 1552), *brown-eyed* (*ibid.*, 1865), we find the names of Alan lethermouth (Patent Rolls, 1330–4), William swetemouth (Freemen of York, 1346–7), John fayerher (Patent Rolls, 1258–66), Geoffrey godherte (Close Rolls, 1204–24), John bruneye (Patent Rolls, 1313–17). The first N.E.D. record of *flaxen*, applied to the hair, is from Shakespeare (Hamlet, IV. v. 196) ; but cf. Richard flaxennehed (Hundred Rolls, 1273), Hugo flaxenebert, i.e. beard (*ibid.*). Of the hundreds of such formations enumerated in Miss Pilkington's thesis, only a very few have been granted the hospitality of the N.E.D. Here are a few with contrasted dates :

N.E.D. Record.		Surname Record.
bullhead (= blockhead)	1624	John boleheved (Hundred Rolls, 1273).
giddyhead	1641	William gidyheved (City Letter-Books, 1327–77).
greybeard	1579–80	Richard greyberd (Hundred Rolls, 1273).
pink-eye (pink = narrow)	1575	Henry pinkeneye (*ibid.*).
meal-mouth (= mealy-mouth)	1540	Henry millemuth (Northumb Assize Rolls, 1279).
cherry-cheek	1447	William chericheke (Patent Rolls, 1323–7).
sheepshank	1675	Thomas shepeshank (Close Rolls, 1223–7).
spindleshank	1570	Adam spindelschanke (Norwich Records, 1269).
lightfoot	*c.* 1440	Boidinus lighfot (Close Rolls, 1224–7).
rawbone	1593	Peter rabayn (Patent Rolls, 1321–4).

Out of a large number of compound costume-names I will take only two obsolete terms familiar to students of Chaucer. Sir Thopas wore "jambeaux," i.e. leg-armour, of *quyrboilly*, a material of boiled leather (French *cuir bouilli*), and the Clerk of Oxenford had a threadbare *courtepy*, i.e. short pea (jacket). Both words are a little older than Chaucer. The first is in Barbour (1375), the second in Langland (1362). But William curbuill (Percy Cartulary, *c.* 1240) and Henry curtepie (Patent Rolls, 1258–66) point to a probably much greater antiquity of both.

Among nicknames taken from animals, birds occupy the chief place. Some of the compounds, e.g. Sparrowhawk, Nightingale, Woodcock, are of Anglo-Saxon origin, but there are also many which appear to be of Middle English formation. The following occur, among others, as surnames :

N.E.D. Record.		Surname Record.
bullfinch	1570	Lawrence bulfinch (Inquisitiones post Mortem, 1316–27).
kingfisher	*c.* 1440	Henry le kingesfissher (Patent Rolls, 1321–4).
nuthatch	*c.* 1340	Richard notehach (Patent Rolls, 1281–92).

The odd character of this type of name is well illustrated by Thomas gosonthegrene (goose on the green) (Norwich Records, 1289). Names other than those taken from birds which antedate considerably the N.E.D. are—

N.E.D. Record.		Surname Record.
bell-wether	*c.* 1430	Richard bellewether (Patent Rolls, 1321–24).
church-mouse	1731	Robertus chirchmus (Pipe Rolls, 1165–6).
hog-lamb	1818	Stephen hoglambe (Patent Rolls, 1313–17).
mouse-hunt (= weasel)	1481	Rogerus mushunte (Pipe Rolls, 1160–1).
puss-cat	1565	Robert pusekat (Northumb. Assize Rolls, 1256).
wild-cat	*c.* 1400	Ricardus wildecat (Pipe Rolls, 1175–6).

From the remaining classes I select a few miscellaneous examples:

N.E.D. Record.		Surname Record.
free-woman	1011	Matilda frewoman (Hundred Rolls, 1273).
gentleman	1275	Adam gentilman (Domesday of St. Paul's, 1222).
lady-love	1733	Thomas lavedylove (Lanc. Assize Rolls, 1285).
penny-father (= miser)	1549	William penifader (Close Rolls, 1288–96).
penny-man	*c.* 1440	William peniman (Hundred Rolls, 1273).
"An impersonation of money, also called Sir Penny" (N.E.D.).		
goodspeed	1526	Radulph godisped (Hundred Rolls, 1273).
sweet-love	1560	Peter swetlove (*ibid.*).
barleycorn	1382	Geoffrey barlicorn (*ibid.*).
haycock	*c.* 1470	Henry haycock (Patent Rolls, 1258–66).
honeydew	1577	Robert honiedewe (Salisbury Cartulary, 1230–40).
may-bush	1579	William mabussh (Close Rolls, 1313–18).
oat-hull (= husk)	1607	William otehule (Pipe Rolls, 1182–3).
pease-cod	1362	Robert pesekod (Charter Rolls, 1257–1300).
flint-hard	1594	James flinthard (Hundred Rolls, 1273).
halfpenny	*c.* 1330	Simon halpenny (Charter Rolls, 1226–57).
lodestar	*c.* 1386	James lodsterre (Hundred Rolls, 1273).
ninepence	1603	Adam ninepenyz (Bishop Kellawe's Register, 1280–1345).
plough-day	1550	William plouday (Hundred Rolls, 1273).
snowball	*c.* 1400	Pavia snawball (Fines Rolls, 1246–72).
twopence	*c.* 1450	Walter twapens (Patent Rolls, 1330–4).

The examples quoted in this short article are mostly chosen as illustrating a considerable divergence of dates between dictionary records and the proved existence of the compound as a nickname. There are also cases in which a difference of only a century may be very significant. The N.E.D. dates *husbandman* from *c.* 1330; but the name of John husebundeman in the Patent Rolls for 1225–32 seems to prove that the compound must have been familiar in late Anglo-Saxon, for no man would be officially described by a word which was not generally intelligible and of fairly ancient date.

The Structure of the Universe

By the Rev. Hector Macpherson, M.A., F.R.A.S., F.R.S.E.

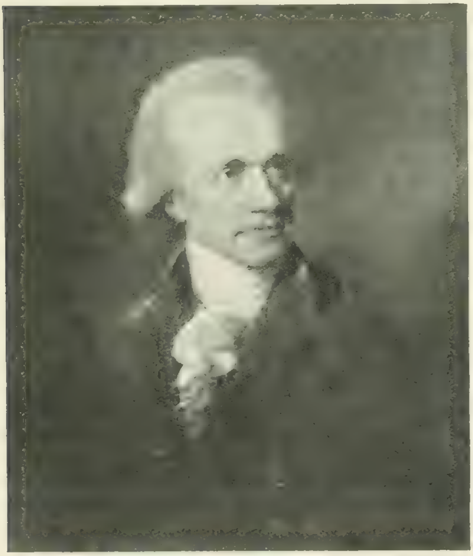
I. Observation and Theory Before 1900

In Roman and mediæval times the human mind was not exercised by such questions as the structure of the Universe. The general order of nature was believed to be fairly well known. The earth was the hub of the Universe, fixed and immovable in the centre of creation. Round the earth, at various distances and in different periods, revolved the sun and moon and the five planets or wandering stars, while beyond was the sphere of the "fixed" stars. But this simple and easily comprehended view of the universe had to be abandoned when in the early seventeenth century the truth of the Copernican system was demonstrated by the discoveries made by means of the newly-invented telescope. The earth was perceived to be merely one—and by no means the largest—of several planetary worlds revolving round the sun; so far from being the centre of creation, our world was seen to occupy a very humble place in the scheme of things.

At first the attention of astronomers was practically confined to the motions and physical condition of the various bodies in the solar system. When Galileo, Kepler, Newton, or Huyghens dealt with the "fixed" stars, they did so incidentally, and their views concerning them were mere guesses. Before the time of Herschel, the stars were observed chiefly as convenient reference-points for the determination of lunar and planetary positions and motions. One important discovery was made almost accidentally as far back as 1718. In that year Halley announced that the four bright stars, Sirius, Arcturus, Aldebaran, and Betelgeux were distinguished by a proper motion, and in the course of the eighteenth century about fifty-seven proper motions were detected. About the middle of the century Thomas Wright, of Durham, put forward his theory of the sidereal system, and in this line of speculation he was followed by Kant in 1755, and by Lambert in 1760.

The problem of the construction of the universe was, however, first tackled in earnest by Sir William Herschel. Previous speculations were not based on observation, so at the very beginning of his astronomical career, Herschel commenced the systematic study of the stars—their distribution and motion—with a view to formulating a definite theory of the sidereal system. His brilliant discovery of the solar motion was but a preliminary to his greater research.

"A knowledge of the construction of the heavens," he wrote in 1811, "has always been the ultimate object of my investigations." In 1784, in his first paper on the subject, he described his method of star-gauging, which, he said, "consists in repeatedly taking the number of stars in ten fields of view of my reflector very near each other, and by adding their sums and cutting off one decimal on the right, a mean of the contents of the heavens, in all the parts which are thus gauged, is obtained." In 1785 Herschel outlined his theory of the universe. "That the Milky Way," he said, "is a most extensive stratum of stars of various sizes admits no longer of the least doubt, and that our sun is actually one of the heavenly bodies belonging to it is evident." The distant nebulæ were looked upon as external universes, and in 1785 he remarked that he had discovered 1,500 universes. Herschel made two important assumptions—that his gauging telescope was sufficiently powerful to penetrate to the limits of this stratum, and that the stars were distributed with some approach to uniformity. Obviously, if these assumptions are granted, the number of stars in any given region of the heavens becomes a criterion of the depth of the stratum in that direction. Herschel was thus enabled to estimate the possible dimensions and shape of the sidereal system. He sketched it as a cloven disc of irregular outline, extending much farther in the direction of the Milky Way or Galaxy than in that of the galactic poles, the cleft representing the division in the galactic stream. The sun he believed to be almost, but not quite, centrally placed, being slightly nearer to the north galactic pole than to the south, and perceptibly closer to the boundaries of the system in the direction of Canis Major than of Aquila.



SIR W. HERSCHEL.
By kind permission of the S.P.C.K.

On the disc-theory, then, the sidereal system was believed to be of limited, though vast, dimensions, and the nebulæ were regarded as external universes which appeared irresolvable through immensity of distance. As his investigations progressed, Herschel was obliged to modify his early conclusions. He came to believe, correctly, that many of the nebulæ were gaseous objects, and not clusters of stars at vast distances. In 1811 he definitely abandoned his belief—never very confidently held—of an equal scattering of stars. "An equal scattering of stars," he said, "may be admitted in certain calculations; but when we examine the Milky Way or the closely compressed clusters of stars, of which my catalogues have recorded so many instances, this supposed equality of scattering must be given up." He did not altogether abandon the supposition, for "a certain properly modified equality of scattering" formed the basis of the second method of star-gauging, which he applied to the Galaxy in 1818. The first disc-theory, however, was abandoned, and Herschel did not put forward another definite hypothesis. At the close of his career he regarded the sidereal system as of greater extension in the direction of the Galaxy than he had formerly believed. He found that "the utmost stretch of the space-penetrating power of the 20-foot telescope could not fathom the profundity of the Milky Way," and he maintained that, "when our gauges will no longer resolve the Milky Way into stars, it is not because its nature is ambiguous, but because it is fathomless." At the close of his investigations, therefore, Herschel viewed the universe as a more flattened disc than he did at the beginning, and he appears still to have looked on the Milky Way as in the main an optical phenomenon, while conceding the objective reality of the regions of streaming and clustering.

Herschel's successor in the study of star-gauging was his son, Sir John Herschel, who completed his father's work by a survey of the southern hemisphere. Sir John Herschel, however, does not appear to have been aware of the gradual progression in his father's views, for in his *Outlines of Astronomy* he reproduced the disc-theory of 1785, referring to it as "the view of the construction of the starry firmament taken by Sir William Herschel." The younger Herschel nowhere put forward a definite theory of the structure of the universe. He did not, however, adhere slavishly to the views put forward by his father. Indeed, in 1836 he wrote from South Africa to Sir William Rowan Hamilton: "It is impossible to resist the conviction that the Milky Way is not a stratum but a ring."

The first astronomer who made an exhaustive study of the elder Herschel's papers and noticed his reiterations of opinion was Wilhelm Struve, the German director of the Russian National Observatory at Pulkova. Struve was also the direct successor of Herschel as an original investigator of the problem. His own study of stellar distribution led to the formulation in 1847 of his modification of the original disc-theory. The universe was, he believed, of finite thickness—the stars being obviously limited in number in the direction of the galactic poles—but of infinite extension in the direction of the Galaxy. He maintained, indeed, that this was borne out by Herschel's later investigations, and that when Herschel spoke of the Galaxy as fathomless, he meant that it was unfathomable. Along with this view of an infinite extension in the galactic plane, Struve advanced his theory of the extinction of light in space—maintaining that the more distant of the galactic star-clouds were rendered invisible by the extinction of light. Struve's hypothesis was rejected by the majority of his contemporaries; and their rejection has been justified by subsequent research. Grant and the younger Herschel showed that in important respects it failed to explain the observed facts; while Encke demonstrated that the theory was based on five assumptions, all of which were questionable.

The work of Proctor in England may be regarded as analogous to that of Struve on the Continent. He made an exhaustive study of Herschel's papers, and proved beyond a doubt that the detailed disc-theory of 1785, with its corollary—the hypothesis of island universes—had been definitely abandoned by Herschel. His own views of the universe represented a reaction from the views of Struve; he regarded the universe as much less extended in the plane of the Galaxy than Struve, or even Herschel, had believed. "Where," he wrote, "Herschel thought he was penetrating to the extreme limits of the sidereal system, he was in reality only analysing more and more searchingly an aggregation in which many orders of stars were mixed up. What he failed to do was not, as he supposed, to sound the Galaxy, but to recognise as separate stars the minutest order of orbs included within such aggregations." Proctor believed the stars composing the Milky Way to be smaller and more closely crowded together than those in the vicinity of the sun. In his view, therefore, the extent of the sidereal system was much less than Herschel had believed it to be, although he admitted that we "are still bound to accept a considerable extension of our system in the galactic plane as fairly deducible from the gauges of Sir W. Herschel."

In 1870 Proctor plotted on a single chart all the stars, to the number of 324,198, contained in Argelander's *Durchmusterung*. This chart revealed the aggregations of the brighter stars towards the galactic plane—a discovery abundantly verified by the independent work, years afterwards, of Schiaparelli and Gore—and also the connection between bright stars and the nebulous light of the galactic background. "It is," he said, "utterly impossible that excessively remote stars could seem to be clustered exactly where relatively near stars are richly spread." The general conclusion which Proctor reached was that "the sidereal system is altogether more complicated, altogether more varied in structure, than has hitherto been supposed. Within one and the same region coexist stars of many orders of real magnitude, the greatest being thousands of times larger than the least. All the nebulæ hitherto discovered, whether gaseous or stellar, irregular, planetary, ring-formed, or elliptic, exist within the limits of the sidereal system. They all form part and parcel of that wonderful system whose nearer and brighter parts constitute the glories of our nocturnal heavens."

The excess of bright stars on the Galaxy was interpreted by Proctor as indicating that the bright and faint stars were comparatively close together, and in this he was followed by Gore. Celoria, however, interpreted the fact as indicating the existence of two galactic rings, while Gould believed the "secondary galaxy" of lucid stars to be due to the existence of a flattened cluster of bright stars comparatively close to the sun. This suggestion, however, did not receive much attention, and was rejected by both Gore and Newcomb. The former astronomer, writing in 1898, regarding Kapteyn's revival of Gould's suggestion in another form, expressed the view that "the sun is a member of a cluster of stars, possibly distributed in the form of a ring, and that outside this ring, at a much greater distance from us than the stars of the solar cluster, lies a considerably richer ring-shaped cluster, the light of which, reduced to nebulosity by immensity of distance, produces the Milky Way gleam of our midnight skies."

This conclusion, however, was not altogether supported by the exhaustive investigations on stellar distribution carried out by Seeliger, of Munich, from 1884 to 1898. Newcomb, writing in 1901, referred to these researches as "the most thorough study of the distribution of the great mass of stars relative to the galactic plane." Dealing with over 100,000 stars, Seeliger demonstrated the gradual increase of the number of stars from each of the galactic poles to the Milky Way. Now, if the Galaxy were simply a ring of stars surrounding a star-sphere, the number of stars would increase not gradually, but suddenly near the boundary of the ring. "The Milky Way," said Seeliger, "is no mere local phenomenon, but is closely connected with the entire constitution of our stellar system." Seeliger, in thus emphasising the fundamental importance of the galactic zone, was led nearer to the standpoint of the elder Herschel.

At the close of the century, several estimates had been made of the possible extent of the stellar universe. When the original disc-theory was propounded by Herschel, the actual distances of stars were unknown; but he assigned to the universe in its greatest extension a diameter 850 times the mean distance of stars of the first magnitude—the thickness of the disc, in the direction of the galactic poles, being 155 of these units. More definite estimates were possible after the measurements of stellar parallaxes had indicated the scale on which the universe is built. Newcomb, in 1901, estimated the distance of the stars at the boundary of the universe as 3,000 light-years[1]; and as the sun was believed to occupy a fairly central position, this indicated a diameter of 6,000 light-years. Seeliger, on the other hand, placed the limits of the universe at 9,000 light-years from the sun, the diameter being about 18,000 light-years. More modest estimates were adopted by other competent authorities.

At the close of the century, it was believed to be definitely established that all the star-clusters and nebulæ were situated within the stellar universe. The "island universe" theory which Herschel put forward as the corollary to the disc-theory, but afterwards virtually abandoned, appealed to the imagination, and retained its place for many years in popular volumes on astronomy. But it did not survive the vigorous criticism of Proctor, Gore, and other writers. Its partial revival during the last decade has been one of the most remarkable features of modern astronomy.

The problem of the construction of the universe may be attacked from three different standpoints—stellar distribution, motion, and distance. The earlier astronomers were forced to concentrate on ascertaining the facts of stellar distribution, and had to be content with deductions from these facts. Even down to the close of the nineteenth century, the known motions and distances of the stars were too few and in many cases uncertain to warrant the formulation of a hypothesis based upon them. Mädler, it is true, made a bold attempt to locate the centre of the sidereal system from a discussion of proper motions, which seemed to point to Alcyone, the chief star of the Pleiades, as the centre of the universe; but his failure indicated clearly that the time was not ripe for such generalisations. The twentieth century, however, has witnessed a remarkable extension of our knowledge of the stellar system. Not only have the refined measures of parallax and of proper and radial motion made during the second half of the last century contributed to this, but new methods of measuring the absolute magnitudes of individual stars and of stars in clusters have been devised, and from these measures the distances of large numbers of celestial bodies have been computed. To a consideration of these recent advances and discoveries a second article will be devoted.

NOTE.—A bibliography will be given next month. The best book on this part of the subject is that by the author on *Herschel* (S.P.C.K. [illegible]) from which by kind permission, the photo of Herschel is reproduced.—ED.

The Discoveries in Crete

By George Glasgow, B.A.

(*Continued from October No., p.* 316)

VIII

THE Cretans had a system of writing as long ago as 2500 B.C. The language therein embodied is still a mystery to us, in spite of Sir Arthur Evans's monumental work *Scripta Minoa* (1909). One hopes that in a further volume Sir Arthur may have found a clue to the mystery, but up to the present the bleak fact remains that there is no adequate starting-point for any attempt at interpretation. If only a bilingual inscription could be found—a Cretan document, that is, side by side with a translation in some known language such as Egyptian—a start could at once be made.

It was inevitable that the art of writing should be evolved early in the history of man. Even in the most primitive stages of life there would be the elementary necessity, for instance, of identifying one's own property, and for this the most likely means would be some system of marking. Then, again, the development of communal life would entail the duty of keeping appointments, or of doing a particular thing at a particular time. It would, one thinks, have been too much of a strain, even for the mind of a Stone Age man, to keep all the details of his daily, still more of his annual, routine in his head, and the handkerchiefs of those remote days (assuming, as one must, that they had any) may not have been of such a material as to lend themselves readily to mnemonic knots. It is quite conceivable, as an instance of the sort of necessity that would arise, that at a given time it could be calculated how many days ahead the provisions in hand would last, and when, therefore, the hunter must be ready for the hills. He might prepare a handy reminder by roughly drawing a spear-head, say, together with a pictographic representation of some commonplace event that was to take place at the same time, and by hanging the picture up in an obvious spot.

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[1] A light year is the *distance* travelled by light in a year. Light travels at the rate of 186,000 miles per second.

One's range of activity would increase as time went on, and it might conceivably be necessary to deliver a message to a man over on the other side of the valley in circumstances where one could not take it oneself. Such a contingency would produce some form of written message, for the message might be private or unsuitable for oral transmission by a third party. To give a concrete example from later times [1]: Proitus wanted to kill Bellerophon, but did not want to do it himself; he therefore sent the doomed man to the King of Lycia "with letters of introduction written on a folded tablet, containing much ill against the bearer . . . that he might be slain." It would have been tactless to transmit such a communication orally by the bearer.

Fifty, even forty, years ago it was the general doctrine of Greek scholars that the Homeric poems were never written down till long after they were composed, perhaps even, so some thought, not until 560 B.C. Till then, we used to be taught, they were preserved wholly by memory and by oral transmission. But on the strength of the above passage from Homer —the only passage in either *Iliad* or *Odyssey* where writing is mentioned—Andrew Lang in 1883 argued that the art of writing must have been known to the early Greeks. "It is almost incredible," he said, "that the quick-witted Greeks should have neglected an art which met them everywhere in Egypt and Asia." He argued better than he knew. Not only was the art of writing known to the early Greeks, but it was known to their forerunners a few thousand years earlier, forerunners whose very existence was not suspected when Andrew Lang wrote. Curiously there had been found no trace of writing in the Mycenæan remains, although this fact has since been shown to be due to mere chance.

In 1893 Sir (then Mr.) Arthur Evans caused general astonishment by communicating to the Hellenic Society his discovery of the fact that certain seal stones which he had found in Greece, and which had been assumed to be Peloponnesian, were in fact Cretan. This startling revelation was clinched during the years that followed by the discovery of further specimens of Cretan writing. Excavation in Crete was started in 1900, and the first year's work yielded up hundreds of clay tablets inscribed with Cretan writing. Was Homer writing fairy stories when he made Proitus send his doomed Bellerophon to Lycia with his "folded tablet"? Or did he know that the Lycians were colonists from Crete?

A tentative sketch of the successive phases through which the art of writing passed may be made, even if it largely depends upon unconfirmed surmise. The temptation to fill in the gaps by what seems reasonable conjecture is hard to resist.

Minoan writing must have started, quite naturally with simple pictographs, such as have, in fact, been found—simple pictures of a man, a leg, a ship, representing a definite thing that it was desired to indicate. They are called "ideographs" because they signify

THE CUP BEARER.

The [illegible] portrait [illegible] the [illegible] the [illegible] Palace at Knossos was found the [illegible] the cup bearer [illegible] dignity, carrying a gold and silver vase before him. The fresco had fallen into the corridor when the connecting wall broke down."

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[1] Homer, *Iliad*, vi. 169.

a single idea. They next developed into "hieroglyphs," that is, pictures which had acquired by association a certain use among the people who employed them, but whose original meaning has been lost, and can now only be inferred. In the parallel case of Egyptian hieroglyphics, guessing at such meanings has been shown to be dangerous work, for in many cases the established interpretation is far other than what one might have supposed.

The first pictographs were evolved in the Early Minoan period (*c.* 2800–2600 B.C.), and are found on seal stones. It may fairly be assumed, therefore, that in Crete the first method of writing down ideas was by seal impressions. By the Middle Minoan period the seal stones are elongated, and contain a succession of designs, by which a connected chain of ideas could be reproduced. The lines of pictures are sometimes read from left to right, sometimes from right to left, a feature in which, as in others, they resemble the Hittite system of writing. In all cases the document is read in the direction in which the figures it contains are facing. *Scripta Minoa* (p. 203) gives a typical example of this species: namely, a picture of a ship with two crescent moons, of which the probable meaning was a voyage of two months' duration.

The next step in the evolution of writing came, no doubt, when phonetic values were assigned to the pictures; that is, when the sound made in pronouncing the name of a given thing or person or action became associated with the conventional ideograph which represented that thing or person or action. When that happened, the same ideograph began to be used in writing out other, more complex, words in which the same *sound* occurred, although in *meaning* there was no connection with the original pictograph. To take a hypothetical example. Suppose we were in that stage of evolution to-day. We may have formed the habit of denoting an axe by a simple picture of that instrument; thereafter the sign of an axe would have become a symbol for spelling the same sound whenever it appeared in any other word. In spelling the word "accident," for instance, we should start with the picture of an axe. This sort of thing seems to us mere "punning," but it would cause no more difficulty or hesitation to the primitive writer whose attitude we are reconstructing than it would have, say, to Mr. Weller senior, to whom the relation of the written to the spoken word and of words to things was still mysterious. Once begun, the method would be eagerly applied to fresh words.

The first attempt at "syllabics," or the writing out of a word by separate symbols for its separate syllables, was made more intelligible by the use of "determinatives." By "determinative" is meant a pictographic representation of the idea denoted by the whole word. These we find appended to the spelling of a word in order to give the reader at least some inkling as to whether the word denoted mineral, animal, or vegetable. A man's name, for instance, would be followed by a picture of a man.

The physical strain involved in drawing pictures every time one wanted to write down a word or two would obviously soon become intolerable. It is not therefore to be wondered at that, by the time of the Middle Minoan III period, the hieroglyphics have been simplified into conventional signs which are easier to make. Herein is the germ of what we call "linear" script, that is, of a system of writing based on a set of regular forms, such as our own alphabet. By the Late Minoan I period there was a full linear script in use throughout Crete, and it was extended to Melos and Thera. Sir Arthur Evans has entitled this script "Class A" to distinguish it from a parallel form of it which was introduced in the next period (L.M. II), and which he calls "Class B." The latter is not a different script, but merely a variation introduced, it is supposed, by a new dynasty at Knossos. Most of the Knossian tablets that have come down to us belong to the "Palace period," and are written in the Class B style.

It was the usual practice to write the inscriptions with a stilus, that is a pointed rod of metal, on a clay tablet, and this is the form of most of the inscriptions that have been preserved. It is possible that wooden tablets covered with a layer of wax were also used; but even if they were, none of them, of course, could have survived the burning of the palaces. More interesting still is the fact that pen and ink must have been used even in those remote times. This fact is established by the discovery of two cups (M.M. III) which are inscribed in ink. There can be little doubt, therefore, that long documents and any literature there happened to be were written in ink on papyrus. It is probable that we shall have to make up our minds to the complete loss of all such literature, for Cretan soil lacks the dryness of the Egyptian. If our worst fears prove true, we may experience the final anticlimax of the discovery that the clay tablets, when read, will contain nothing after all but lists and bills and the like.

It is indeed obvious that many of the tablets consist of bills or inventories. Although we cannot yet understand the language of the script, it has been found possible, by studying the clay tablets, to reconstruct the system of numbers that was used. We have, for instance, what is evidently an inventory of arrows, a record surmounted by a picture of an arrow. From this and other records it is apparent that thousands were expressed by "diamonds," hundreds by slanting lines, tens by circles, units by straight lines, quarters by a small "v." The highest number recorded is 19,000.

Although it is true, as already stated, that scholars still await a clear starting-point for transcribing the Cretan script, there is one interesting and important point already established by Sir Arthur Evans. He has proved that the Phœnician alphabet, which had always been supposed to be the original source of the Greek alphabet, and therefore of the Latin alphabet from which comes our own, was itself derived from Crete.

There are in existence three fragmentary inscriptions, two of which were found not long ago by Professor R. C. Bosanquet at Præsos, in Crete—near to Mount Dicte, and not far to the north-east of the boundaries of Knossos—which are written in Greek characters, and are therefore quite legible to us, but which contain a language which is not Greek. Is it the language of the Minoans? On this thorny question I must leave it to Professor Conway, who has examined them at length in the *Annual* of the British School at Athens,[1] to find what can be said—if anything can be—to the readers of DISCOVERY.

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[1] Vol. viii, p. 125, and vol. x, p. 115

(*To be concluded*)

Wireless Telephony

By Lieut.-Col. C. G. Crawley, M.I.E.E.

IN communicating by speech in the ordinary way, energy is transferred from the speaker to the listener in the form of air waves, these waves being produced by oscillations, to and fro, of the little particles of air These air oscillations are set up by the voice, and are received as air oscillations in the ear, where they set the drum in vibration, so producing the sensation of sound. In line telephony the air oscillations set up by the voice actuate an instrument, the microphone transmitter, which varies the strength of the electric current flowing along the line. These variations of the current work the receiving instrument, the telephone receiver, in such a way as to produce sound waves precisely similar to those which caused the variations at the sending end. In this way the energy of the air oscillations at the transmitter is transformed into the energy of current variations in the line, and retransformed into sound at the receiver.

In the case of wireless telephony the procedure is very similar, except that the variations of a current flowing in a system of elevated wires, called the aerial or antenna, produce variations in the continuous stream of ether waves which this current causes to be radiated in all directions, and these ether waves cause a current with similar variations to flow in any other aerial which they meet.

In ordinary speech, therefore, air waves proceed direct from the sender to the receiver; in line telephony they vary an electric current which produces similar air waves at the receiver; and in wireless telephony they vary an electric current which produces variations in ether waves, which in their turn produce similar air waves at the receiver.

The medium by which energy is transferred in line telephony is the wire connecting the sender to the receiver, whereas in wireless telephony the medium is the ether which connects all senders to all receivers, and it is this fact which constitutes the great advantage of the latter, viz. all senders are at no cost automatically connected to all receivers. It must not be thought, however, that such a great advantage can be attained without dragging some serious disadvantages in its train. The use of the same medium, for instance, leads naturally to difficulties in selectivity—that is, one communication being interfered with by others, or by electrical disturbances in the ether itself, such as those caused by lightning. Interference between various communications is overcome to a great extent by arranging that different lengths of waves in the ether are used for different communications, the apparatus for one communication being adjusted to respond much better to ether waves of one special length than to those of any other. When the apparatus at each end are thus arranged for transmitting and receiving respectively ether oscillations of the same rate, they are said to be in tune with one another, and the greater the number of different communications required, the greater are the number of various rates of oscillation that must be arranged for. Now, it is just this requirement that makes an extensive network of different communications very difficult and often impracticable, because for good working over approximately the same range, the various wave lengths that can be economically used are strictly limited. Wireless telegraphy makes use also of ether waves, and requires the same wave lengths as are suitable for telephony, so that the available field for selection is still further reduced. With line telephony, on the other hand, there is of course no such limitation, separate wires being used for each of the various communications.

The other trouble mentioned, that of interference from electrical disturbances in the ether, is also very serious, just as it is in the case of wireless telegraphy. These disturbances, or "atmospherics," are very troublesome indeed in tropical climates, and even in temperate latitudes they produce much interference in the summer months. For "broadcasting" a message—that is, sending a message out to all stations within range which are adjusted to receive it—the difficulty as regards wave lengths is of course reduced, and some interesting demonstrations on these lines have recently been given in this country. On one occasion last June, Dame Melba sang into a transmitter at the Marconi Company's station at Chelmsford, and the songs were heard clearly at many wireless receiving stations on land and sea up to distances of several hundreds of miles. It is possible that such a broadcasting system might be utilised for news messages to daily papers, and tests have recently been carried out for the Press Association. These tests, however, showed that such an arrangement was not suitable for immediate use.

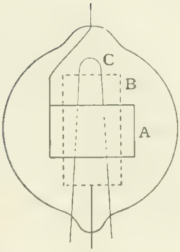

FIG. 1.

A three-electrode transmitting valve. A is a plate of sheet metal. B is a cylinder of narrow mesh wire gauze. C is a wire filament. The glass vessel is highly evacuated.

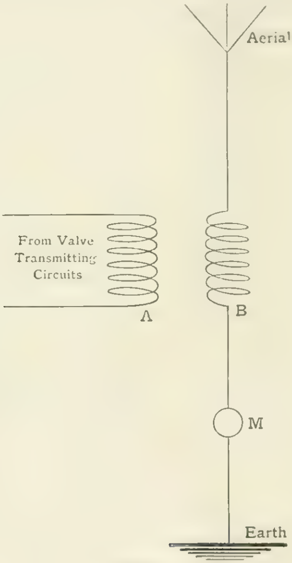

FIG. 2.

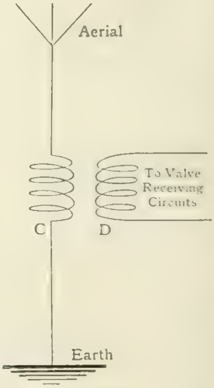

FIG. 3.

In comparison with wireless telegraphy, the advances in wireless telephony were extremely slow until about six years ago, when the Three-Electrode Thermionic Valve was introduced as a generator of wireless waves. Since then, however, such rapid progress has been made that its great future is already well assured. The principal reason why telephony lagged so far behind was that a continuous radiation of uniform ether waves which could be modulated by the voice was essential, whereas in telegraphy a radiation of groups of waves sufficed, a radiation such as was obtained from the spark generators used in all the earlier wireless telegraph transmitters. The first real attempts at wireless telephony were made possible when arc generators and high-frequency alternators were introduced. Even these, however, did not produce radiation of exactly the sort required, and it was undoubtedly the introduction of the Three-Electrode Valve as a generator that gave wireless telephony a fair start.

The Three-Electrode Thermionic Valve (Fig. 1) consists essentially of a vacuum bulb similar to the ordinary incandescent lamp, but with two metallic electrodes inside the bulb in addition to the filament. When this instrument is connected with suitable circuits to a source of electric power, electric oscillations—that is, electric currents oscillating at very high speeds—are generated, and when these currents are caused to flow in an aerial, a continuous stream of uniform ether waves is radiated. For telegraphy, these oscillations, and hence the waves, are broken up into short and long groups by a signalling key, corresponding to the dots and dashes of the Morse Code; and for telephony they are modulated by the voice speaking into a microphone, just as the current in the line is modulated in line telephony. A common form of microphone consists of a small chamber filled with carbon granules through which the current flows, the current remaining constant so long as the granules are quiescent, but varying in strength owing to the varying electrical resistance, as the granules are made to vibrate by the voice.

The microphone transmitter may be placed as in Fig. 2 at M in the aerial itself, so as to modulate the currents in the aerial, or may be placed in the valve circuits, so as to modulate the currents at the source, the energy in either case being transferred from the valve circuits to the aerial by the currents in coil A, inducing exactly similar currents in coil B. At the receiving end (Fig. 3), the currents produced in the aerial by the wireless waves are exactly similar in form to those in the sending aerial and flow through coil C, inducing exactly similar currents in coil D, which is connected to the valve receiving circuits in which the telephone receiver is inserted. The aerial in land and ship stations is supported by masts, and in aircraft is let down as a trailing wire or is made up as a coil in the aircraft itself. The " earth " consists of metal plates or wires in the ground or water, or, in the case of aircraft, metallic portions of the fusillage.

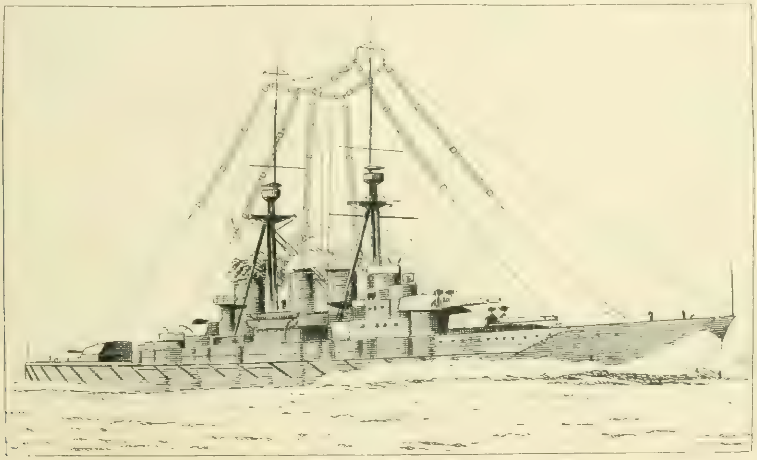

FIG. 4.—SHIP AERIAL.

It was only a year or so before the outbreak of war that experiments were commenced with wireless telephony using the Three-Electrode Valve as a transmitter, and during the war nearly all work carried out in Europe on wireless telephony was directed towards the development of small sets, especially in connection with aircraft. This was largely due to the fact that in aeroplanes the use of wireless telegraphy entailed the pilot or observer being trained as a telegraphist, and acting as such in addition to his other duties, as it was usually impracticable to carry a wireless operator for wireless duties only. Pilots and observers had plenty of other work to get through, and the advantage of having a simple telephone set which could be used with little technical knowledge soon became very apparent. It was in the summer of 1915 in this country that wireless speech was first received from an aeroplane, and there is no doubt that our Flying Corps was the pioneer in this method of aircraft communication. One of the first successful demonstrations of wireless telephone working from aircraft in France was given to Lord Kitchener at St. Omer. Unfortunately, however, the messages from the aeroplane were heard as far away as Lowestoft, and further experiments were prohibited for quite a long time, as it was thought that the enemy might obtain some valuable information by reading our messages.

In 1915 most pilots considered all wireless more as a nuisance than anything else, whereas it has been stated that in 1919 some pilots on the postal routes refused to go up without a wireless telephone. About the time of the Armistice, aeroplanes were normally communicating by wireless telephony with ground stations up to about fifty miles, and with each other up to about five miles, but these ranges have now been more than doubled.

In the United States, during the early part of the war, more time could be spared for experiments with larger sets, and spoken messages were heard at the Eiffel Tower Station in Paris, about 2,300 miles, and sometimes even at Honolulu, about 5,000 miles. Since then other great distances have been accomplished, such as between this country and America, but it must be understood that such long-range working is still in the experimental stage, though its realisation as a commercial proposition is no doubt only a matter of time. There is no great technical difficulty in linking up wireless telephony with line telephony, to allow of the communication being partly by wireless and partly by line. It was in this manner that President Wilson when at sea, returning to the United States after the Peace Conference, received telephone messages from his Ministers at Washington, and more recently business conversations have been conducted from this country in the same way with aircraft flying to Paris.

A limitation to wireless not mentioned above, as compared with line telephony at present, is that the receiver cannot break in when the sender is speaking—that is to say, the listener must wait until the speaker has finished before he switches over to his speaking apparatus. This point need not, however, be discussed here, as, although it is just now a serious disadvantage, it will certainly be remedied before very long.

When consideration is given to the present achievements of wireless telephony in light of the fact that the whole subject is in its infancy, it is easy to foresee very great possibilities, even if we cannot quite reach those heights of technical imagination so easily scaled by the daily Press.

Land and Sea in Greek Life

By W. R. Halliday, B.A., B.Litt.

Professor of Ancient History in the University of Liverpool

In theory at least we are accustomed to derive the city state of the ancient world from an agricultural origin; and, in fact, the small farmer in early Greece and Rome formed the backbone alike of the State and its armies. It was the peasant proprietor who defeated the Persian at Marathon at the outset of the fifth century B.C., who conquered Italy for Rome and defeated Hannibal in the third. But both in Greece and Rome, as civilisation developed and became more complex, the peasant farmer tended to disappear, and small-holdings were squeezed out by estates owned by capitalists and worked by gangs of slaves. The attractions of city life helped to drain the rural districts; and sharp-witted townsmen, then as now, affected to despise the country bumpkin.[1] On moral and sentimental grounds the process was to be regretted. At Rome its attendant evils were aggravated by slavery, which transformed the peasant population into a parasitic proletariat of "mean whites," and its results were disastrous; it was due, however, to an economic necessity which the tinkering of reformers was powerless to alter. For the development of large grazing estates with their summer and winter pastures, and the cultivation of products other than corn which involved capital outlay, were economically sounder than the system of corn-growing peasant holdings in a society which had reached a capitalistic stage. In Greece this development did not operate on so large a scale, nor were its results so severely felt; but, none the less, in fourth-century Athens the peasant proprietor was disappearing. Attica had been ruined by the ravages of the Peloponnesian War; and the agricultural revival preached by Xenophon was to be carried out by men of capital like Ischomachus and his father, who could buy up ruined property cheap and work their estate with an overseer and slaves.[2]

The Romans never liked the sea, and it was only the sheer military necessities of the Punic War in the third century B.C. that compelled them for the first time to build a fleet. Indeed, the great Roman poet Lucretius betrays the attitude of his countrymen towards the sea when he opens the second book of his poem on Nature by remarking that it is pleasant to stand safely on the shore and watch less fortunate people on the sea having a bad time.

The Greeks, on the other hand, took early to the sea and became a race of mariners and merchants. Nations, like individuals, have to pay their way in the world. The financial basis of Rome was the spoils of empire. Successful wars concentrated the capital of the world in her hands, and her conquered provinces had natural resources which her citizens could exploit. Rome came to live by financing and "developing." Greek prosperity, on the other hand, was based upon seaborne commerce and the command of the carrying trade in the Eastern Mediterranean. Seafaring was congenial to the Greek temperament, and no doubt its practice reacted upon national character. The same adventurous daring as was shown by her mariners in exploring unknown regions and uncharted seas was displayed by her thinkers, scientists, and philosophers in intellectual fields. That is why the Greeks came to be the founders of Western civilisation. Agriculture and seafaring, then, form the background of Greek civilisation; and these are occupations by which a free man can worthily earn his living. For though mining and manufacture play an increasingly important part in Greek economics, the former was wholly, and the latter mainly, carried out by slaves. The

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[1] "Forgive me; I'm an awkward country fool," says Strepsiades when abused for kicking the door of Socrates' Thinking Shop (Aristophanes' *Clouds*, l. 137, trans. Rogers Bell & Sons, 1919. 2*s*.). For the growing contempt of the townsmen for the rustic, see Theophrastus, xiv, with Jebb's notes and references.

[2] See Xenophon, *Œconomicus*. A translation by Dakyns will be found in his *Works of Xenophon*, vol. iii, part 1, p. 197. (Macmillan, 1897.)

Greeks were an open-air people. Their climate encourages the open-air life. They had a correspondingly high standard of physical fitness. They disliked working indoors, and they condemned its physical results. A man's health, they argued, must suffer from being shut up out of the sunlight all day, possibly beside a fire or furnace. And if his body suffered, his mind would suffer too. Such occupations would stunt his mental and moral growth. Industry indoors was no life for a free man. If he has to earn his living, he will do so, they thought, most honourably in the open air as a farmer or sailor.[1] An epitaph in the *Anthology* gives us the alternatives:

TYPICAL GREEK VIEW.

"I am Eteocles, whom the hopes of the sea drew from husbandry and made a merchant in place of what I was by nature. I was travelling on the surface of the Tyrrhenian Sea, but with my ship I sunk headlong into the depths, in a sudden fierce squall. It is not then the same wind which blows on the threshing floor as that which fills the sails."[2]

The lines of Greek development had, in fact, been largely moulded by the physical features of the Balkan Peninsula. About 1000 B.C. the ferment caused by the invasion of the iron-using tribes from Central Europe[3] gradually subsided; and the Ægean area, which had been a seething cauldron of migratory peoples, began to settle down. Now, Greece consists of a tangled mountainous mass with little pockets of plain between its crags. Man cannot live upon mountain-tops of bare limestone, and therefore it was in these pockets, isolated from each other by sea and mountain, in which settlements grew up. This physical isolation bred the peculiar virtues and defects of the city-state: on the one hand an intense love of independence, and on the other the inability to form a successful political combination upon a larger scale. Further, the indented coast-line of Greece, with its main harbours opening towards the homes of older civilisations in the East, and the chains of islands, which offered ready shelter to the early mariner, and, what was even more important to one who had no compass, the perpetual guidance of landmarks, made the Ægean Sea an ideal nursery for early navigation.

The people then settled down in these little plains hedged in by mountains and the sea. It is a law of nature that everything, in order to survive, must adapt itself to its circumstances. So the Northerners had to change their way of life. The Homeric chieftains were still tamers of horses, a pastoral people who reckoned their wealth in oxen; e.g., when Diomed changed armour with Glaucus, Homer remarks what a fool he was to give away arms worth a hundred oxen for arms worth nine. But the country in which the "tamers of horses" were now settled has no wide pasture-lands. Beyond the small arable plain is the rocky mountain. Its prickly scrub will give summer feed for goats and sheep, but is of little use for horses or cattle. In consequence the Greeks ceased to be a pastoral people, and became agricultural.

Below the bare rock of the mountain summits there is a belt of forest, with springs round which green shrubs will grow in the summer when the plain below is parched and baked. In the summer, then, you have the shepherds of the mountains taking up their flocks, as they do to-day, to the cooler altitudes where pasture is to be found, and in winter coming down below the snow-level. Their flocks are sheep and goats which they keep for milk, wool, and goats'-hair.[1] The ancient, like the modern, shepherds were a wild and lawless crowd. The mountains are natural hiding-places for fugitives from justice; they are also the no-man's land between us and the enemy-state across the range[2]; and there are sheep-stealers, two-legged and four-legged, to be dealt with. For there are wild beasts in the forest belt. Wolves were so predatory in Attica that a reward was paid for each wolf destroyed, as it was in early days in England. Boars, too, were to be found and hunted in the forest.[3]

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[1] See, for example, the treatise of Xenophon already referred to

[2] *Greek Anthology*, vii, p. 532 (translated by W. R. Paton in the Loeb Series).

[3] See DISCOVERY, vol. i, pp. 226 and 342.

Below the mountain and on its lower slopes, where patches could be terraced into fields, lived the small farmer. About his life and habits we know a good deal from the poems of Hesiod (eighth century B.C.).

The farmer, then as now, was a grumbler. The climate of Ascra, where Hesiod lived, was "vile; cold in winter, hot in summer, never good." Of course the winter in Greece is cold. Although the sun is warmer than with us, the piercing winds sweep down from the snow-clad hills. "Wretched days they are," says Hesiod, "all of them fit to flay an ox, and the frosts are cruel when the north wind blows over the earth—then all the immense forest roars, and the beasts shudder and put their tails between their legs, even those whose hide is covered with fur; for with his bitter blast he blows even through them, although they are shaggy breasted. He goes even through an ox's hide; it does not stop him. But it does not blow through the tender maiden who stays indoors with her dear mother." It was a great temptation in this cold weather to spend the day gossiping by the warmth of the forge in the village smithy, which in ancient Greece, as in rural England to-day, was the rustic club. Hesiod warns his pupil against the waste of time. "Pass by the smithy and its crowded lounge in winter-time when the cold keeps men from field work, for then an industrious man can greatly prosper his house"; there is plenty to do indoors mending and making gear.

The other close time is the summer. The Greek harvest is in May. In July and August it is too hot for work, and the ground gets baked as hard as brick.[4] Even Hesiod countenances a rest in the summer. "But when the artichoke flowers [June] and the chirping cicada sits in a tree and pours his shrill song continually from under his wings in the season of wearisome heat, then goats are plumpest and wine sweetest, but men are feeblest because the Dog Star parches head and knees and the skin is dry through heat. But at that time let me have a shady rock and wine of Biblis, a clot of curds and milk of drained goats, with the flesh of an heifer fed in the woods, that has never calved, and of firstling kids; then also let me drink bright wine sitting in the shade, when my heart is satisfied with food; and so, turning my head to face the fresh breeze, from the overflowing spring which pours down unfouled, thrice pour an offering of water, but make a fourth libation of wine."[5]

Old Hesiod must have been a good companion to sit with under the shady rock by the fountain. He was a wise old man with the wisdom of those who live patiently with nature. He knows all about the stars and birds and beasts and flowers. It is they who mark his calendar, and he trusts to the observation of their habits in place of the artificial division of months,

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[1] Cattle were kept, as in modern Greece, solely for draught purposes. I remember failing to persuade a Cretan shepherd that it was no traveller's tale, but true, that in England sheep were not milked, but cows were.

[2] Compare the life of the shepherds indicated in Sophocles' *Œdipus Tyrannus*, of which Prof. Murray and more recently Mr. J. T. Sheppard have published translations.

[3] The brown bear was extinct in Attica in the fifth century, but there is interesting evidence of its earlier existence in the bear dance which all Athenian maidens had to perform in honour of the bear goddess, Artemis Brauronia. Lions were well known to Homer, who frequently makes poetical use of their attacks upon flocks and herds. Herodotus gives the rivers Achelous (in Acarnania) and Nestus (on the north coast of the Ægean) as the limits of the distribution of the lion in his day. They attacked Xerxes' sumpter-camels when he was marching through Thrace to the invasion of Greece, and so greatly did they appreciate this new delicacy that they touched, so the historian assures us, neither man nor other baggage animals (Herodotus, vii, pp. 125, 126). Lions were still to be found in Macedonia at the end of the first century A.D. The saga of Meleager and the story of the great boar of Calydon will be familiar. Boar-hunting remained a popular manly sport in Attica down to the fourth century, as references in Aristophanes and the Orators testify. None of these wild beasts are to be met with in Modern Greece, though a few wild goats survive in Crete, and wild pig is fairly common in parts of Asia Minor. I have not myself seen the small brown bear, but was assured that it was to be found in the mountains of Anti-Taurus.

[4] During the war it was necessary to construct a landing-place for Handley-Page aeroplanes near Suda, in Crete. The clods, where the ground was furrowed, were so hard that the only available steam roller made no impression on them, and they had to be broken by hand with picks.

[5] Greeks disliked water-drinkers. "They say," says Demosthenes, "that being a water-drinker, I am naturally a cross-grained and ungenial fellow" (Demosthenes, *Philip*, ii. 30, 73; cf. Aristophanes, *Knights*, ii, 89, 345). But they did not drink their wine neat. The proportion of water to wine varied, and might be decided by the president of the company, who also prescribed the toasts. The normal mixture in the fifth century seems to have been three of water to two of wine (Aristophanes, *Knights*, 1187). The proportion five to two is also mentioned as usual (Athenæus, x, 426).

FLOCKS COMING INTO MAUDIA IN THE MIDDLE OF THE DAY.

THERA THRESHING FLOOR.

e.g. "When you hear the voice of the crane who cries year by year from the clouds above [i.e. in the middle of October] mark it well, for she gives the signal for ploughing and shows that the season of rainy winter is near"; or "When the house-carrier climbs up the plants from the earth to escape the Pleiades [middle of May], then is the time to whet your sickles." The house-carrier is, of course, the snail. Hesiod, like other rustics, has queer old-fashioned names for beasts. The ant is "the Wise One," the cuttlefish "the Boneless One," the burglar "the Man who sleeps by Day." Some things, of course, it is unlucky to mention by name—tombstones, for instance. "Do not let a boy of twelve years sit on that which may not be moved, for that is bad and makes a man unmanly."[1] He knows, too, all about lucky and unlucky days, and he is a mine of rustic lore. The fourth is the lucky day to be married. The fifth is a very unlucky day. Men born on the twentieth of the month in daylight are very wise. The nineteenth is a lucky birthday for boys, and the fourth for girls. Never put the ladle on the mixing-bowl at a wine-party, for malignant ill-luck is attached to that; nor when building a house leave it rough-hewn, for a cawing crow might settle on it and croak.

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[1] The superstitious man in Theophrastus will not tread on a tombstone (Theophrastus, *Characters*, xxviii).

The seasons in different parts of Greece vary, of course, with latitude and altitude; but normally there is no rain from the end of March to October. The spring is wonderful. The hot sun on the ground soaked by the winter rains produces a mass of wild flowers, and the whole ground is carpeted with living colour.

> "All fragrant with woodbine and peaceful content and the
> leaves which the lime blossoms fling,
> When the plane whispers love to the elm in the grove in
> the beautiful season of spring."[1]

Harvest, as we have seen, in most parts of Greece is reaped in May or early June. When the grain has been threshed and winnowed, there is nothing more to be done in the fields until the autumn. Normally, in the Eastern Mediterranean there are two rainy spells, what the Bible calls the former and the latter rains. The former rain, the light rains of autumn, soften the ground. Now is the time for the farmer to go up the mountain side and cut himself timber for a plough. Hesiod advises making two, one being all of a piece, in case of accidents. Now, too, is the time to break up the fallow land; for Greek antiquity did not know rotation of crops, and land cropped one year lay idle the next. The true ploughing season came later in the period of the latter rains. December was the best time, though there were those who affected the late ploughing in March, which in some years produced good results. The sower went behind the plough, scattering the seed, and Hesiod recommends a man to follow him with a mattock to turn the soil over the seed before the birds get at it.[2]

The tools and methods of agriculture in Hesiod's time were very much those in use to-day in modern Greece. The plough is still little more than an iron-shod stake which scratches the surface of the light and stony soil. Deep ploughing would, in fact, be impossible among its boulders.

Corn was reaped with a sickle in May, and then taken to the threshing-floor, a paved, circular space set upon a high place which catches the summer breeze. The grain is threshed either by being trodden out by beasts or ground out by a wooden sledge. This is an oblong frame of wood studded on the bottom with pieces of flint. The driver stands upon it to press it down, and drives round and round over the corn.[3] When this has been shaken out of the ears, it is winnowed by throwing it with a long-handled shovel into the air against the wind. The heavier grain then falls in one heap, while the light chaff is carried further down-wind into another. For this process a gentle, steady breeze gives ideal conditions. "It is not then the same wind which blows on the threshing-floor as that which fills the sails."[4]

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[1] Aristophanes, *Clouds*, 1007 (trans. Rogers).

[2] See British Museum Guide to the Exhibition illustrating Greek and Roman Life, fig. 216, p. 208. A well-known black figured vase by Nicosthenes depicts ploughing and sowing (see *Companion to Greek Studies*, p. 539).

[3] I photographed a Cretan sledge of this type in 1916. On the other hand, similar flints for setting in a threshing sledge were found in one of the prehistoric cities at Phylakopi, Melos. This method has therefore a long continuous history.

[4] A. W. Mair's translation of Hesiod (Clarendon Press, 1908) may be recommended to those who are unable to read the original. The British Museum Guide Books, which give the reader certainly the most wonderful value in archæological publication, containing as they do abundant illustrations, and costing 1*s.* or 1*s.* 6*d.*, are too little known and used. For students of Greek and Roman history the *Guide to the Department of Greek and Roman Antiquities* and that above quoted are invaluable. The Guide Books to the Stone, Iron, and Bronze Age collections, and the excellent handbook to the Ethnographical Section, can also be warmly recommended.

(*To be continued*)

The Future of the Airship in Commercial Transport

By Major George Whale (late R.A.F.)

A SOMEWHAT pessimistic tone is prevailing, at present, concerning the utility of aircraft for commercial purposes. It is true that the development of aerial transport companies has not been as rapid as aeronautical experts hoped would be the case with the coming of peace, but the reason for this is not far to seek. Europe, if not the whole world, is suffering from a state bordering on bankruptcy, with the result that money for scientific research and for the necessary experiments incidental to civil aviation is only forthcoming to a limited extent.

When this is considered, it must be conceded that considerable progress has been made in establishing passenger and mail-carrying services by aeroplane both in this country and on the Continent, as well as in America.

Most unfortunately, the form of aircraft which appears to hold out by far the greatest possibilities, namely the airship, has been neglected entirely as far as Great Britain is concerned.

The successful crossing of the Atlantic by the rigid airship R34 proved that such a flight could be undertaken without undue risk, and it might have been imagined that a great stimulus to airship transport would have accrued.

It is admitted that the saving of time effected by aeroplane flights is largely neutralised by the fact that passengers and cargo have to be landed on the outskirts of cities, and from thence taken to their destination by existing means of transport. This argument, although holding good for flights over a comparatively speaking short distance of ground, cannot be cited against the airship when maintaining services across the oceans and continents, which will shorten the duration of journeys by several days.

In addition, it is possible to build an airship capable of carrying passengers and goods in great quantity without any radical alteration in design, a state impossible of attainment with the aeroplane as at present constructed. This happy position seems to be the crux of the whole question, as it is only the carrying of goods in bulk or passengers in large numbers which will render any aerial transport company a profitable enterprise.

Official figures have been published to show that an airship service can be maintained between this country and India by using airships of the type and capacity of R38, a ship nearing completion in this country which has been sold to the Americans. This ship has a capacity of only 2¾ million cubic feet, and yet could carry over fifty passengers together with mails. The figures, which have been worked out in addition for services to other parts of the globe, give approximate times of transit of 2 days to Egypt, 4½ days to India, 6 days to South Africa, and 9½ days to Australia. Moreover, the suggested passenger fares are not greatly in excess of those demanded by the steamship companies to-day. This undertaking is estimated to produce a profit of 15 per cent., and proves that a return may be expected on capital outlay with the airship as it exists to-day.

Calculations have been made, also, for operating airship services using ships of 3½ million cubic feet capacity. The constructional sheds in this country are large enough to accommodate such vessels. An estimated disposable lift of 68 tons will be attained, of which some 15 tons will be available for passengers and cargo. New York could be reached in 2½ days from London, while it is estimated that the time taken to make the journey between England and Australia would be 7 days, allowing twelve hours for refuelling at Cairo and Colombo.

These figures are in themselves sufficiently astonishing as showing that there is hardly a city in the world which could not be reached from London in less than a fortnight, while the saving in time to business men, both for personal travel and conveyance of letters, must be manifestly of the greatest importance.

There is, practically speaking, no limit whatever to the carrying powers of the airship, as this is determined by merely increasing the size, and the lift is proportional to its cubic capacity. For example, an airship of the volume of 10 million cubic feet would have five times the lift of the airship of 2 million cubic feet, but the length of the former would be only 1·7 times greater.[1]

A ship of this size would have some 200 tons lift available for fuel and freight, and would possess sufficient endurance to voyage round the world without refuelling.

The Germans are aware of the unbounded possibilities open to the airship, and are at the moment under negotiations with the Americans to finance a company to exploit a service with large airships between New York and Berlin. By the close of the war we had reached the position of the leading Power in the air, and it is to be hoped that, when it is realised that the value of airships is appreciated in foreign countries, we shall take every step possible to retain that supremacy.

An Up-to-date Meteorological Equipment—I[2]

By Donald W. Horner, F.R.A.S., F.R.Met. Soc.

RAIN-GAUGES

In a short series of articles, it is intended to deal with up-to-date meteorological instruments, to interest readers generally in meteorology.

In recent years the Royal Meteorological Society has ceased to collect observations, but the Meteorological Office, with its newly acquired branch the British Rainfall Organisation, both require fresh voluntary observers in various parts of Great Britain and Ireland. Rainfall observers are required by the last-named institution, and those wishing to undertake the work are invited to send a post-card to the Superintendent at 62 Camden Square, London, N.W.1, who will send full particulars of how the work should be done, and where rainfall-stations are required most.

It is only by an intelligent comprehension of the geographical distribution of rainfall that eventually we may be made to utilise the vast quantities of water now allowed to run to waste annually.

Rainfall observations are therefore considered of such importance that we shall first of all consider the rain-gauge.

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[1] Since volumes of similar figures are proportional to the cubes of their lengths, and the cube root of 5 is approximately 1·7.

[2] All illustrations except Fig. 4 are from blocks lent by Messrs. Negretti & Zambra, of London

Rainfall is not only influenced by geographical position, but also by the height and proximity of mountains and of the sea, in some cases even of hills and forests. If, therefore, we have a neighbour living on a hill near us who keeps a record of the rainfall, that is not a sufficient reason for our omitting measuring the rainfall by a rain-gauge in our own back garden. In partial storms it is quite possible that we record more than an inch of rain, and our neighbour's gauge remains perfectly dry. The opposite may also be the case.

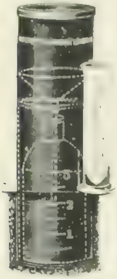
FIG. 1.—SNOWDON RAIN-GAUGE AND MEASURE GLASS.

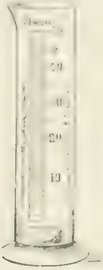
FIG. 2.—CAMDEN MEASURE-GLASS

The instruments described in these articles will be those used at—

(1) Stations of the First Order, or Self-recording Observatories.
(2) Stations of the Second Order, or Normal Climatological Stations.
(3) Stations of the Third Order, or Auxiliary Climatological Stations.
(4) Telegraphic Reporting Stations.
(5) Anemograph Stations.

The descriptions, however, will be given not in the order in which they are used at these stations, but in the order of simplicity in use, commencing with the simplest. Each instrument will be allocated its proper position at each station in a summary in the concluding article.

The best and most usual pattern of rain-gauge in use to-day is the "Snowdon," a gauge having a funnel 5 inches (12·7 centimetres) in diameter.

The funnel has a brass rim at the top, the inner edge of which is cut sharply to the diameter mentioned. The funnel itself is 4 inches in depth.[1]

The reason for adopting this gauge with a deep funnel is that snow cannot blow or hail jump out of it after it has been caught. In old-fashioned rain-gauges with shallow funnels, relatively a large amount of snow was lost during high winds. In consequen the amount of precipitation appeared too little whe measured in these gauges.

A second reliable gauge is the Meteorological Offi pattern rain-gauge. The diameter of the funnel of this one is 8 inches (20·3 centimetres), and except in size is similar in every way to the Snowdon. Observations made with either of these instrument are accepted as equally trustworthy by the Meteorological Office and the British Rainfall Organisation. In purchasing rain-gauges, a prospective buyer will find it best to get a copper apparatus. A coppe rain-gauge costs more initially, but it lasts practicall a life-time, and it does not require periodical repainting as the cheaper ones do. Secondly, he should decid whether he intends to measure the amount of precipitation in inches or in millimetres. It makes no difference in which units the measurements are mad provided one unit is kept to throughout. An inch is equal to 25·4 millimetres, and a millimetre is 0·03937 inch. For convenience, the millimetre may be considered equal to 0·04 inch, but it is clear that if this value be used for converting from one unit into the other, small errors arise, while if the correct value be used, it involves quite a lot of arithmetic. It is best, therefore, to keep to one unit throughout.

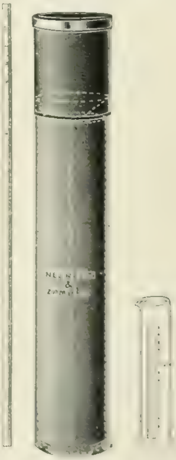
FIG. 3.—BRADFORD RAIN-GAUGE

If the rainfall be measured in inches, a Camden measure-glass is necessary for the estimation of small amounts of rainfall. These glasses hold half an inch and are graduated in tenths and hundredths. There are measure-glasses also graduated in millimetres and tenths. They hold 10 millimetres (approximately $\frac{2}{5}$ inch).

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[1] Experiments made recently by Mr W. H. Dines at Benson Oxford, seem to suggest that the ideal rim should have a slope inside as well as outside, the cross-section being like the gable-end of a house.—*Meteorological Magazine*, June 1920

When it is said that an inch of rain has fallen, it is meant that sufficient water has fallen to fill to overflowing a vessel 1 inch long, 1 inch wide, and 1 inch deep—that is, a cubic inch of water has fallen on every square inch of land. Since an acre contains 6,272,640 square inches, an inch of rain on this area means that 101 tons of water have fallen. For the amount fallen is 6,272,640 cubic inches; 1728 cubic inches equal one cubic foot; a cubic foot of water weighs 62½ lb.; and so, by calculation, we arrive at the above result.

Having decided the kind of gauge to use, our next problem is to select a site as free as possible from such obstructions as buildings, trees, and walls. A good plan is to place the instrument as far away from the obstacle as the obstacle is high. The late Dr. R. H. Scott, formerly Secretary and Director of the Meteorological Office, recommended that "the angle subtended in each azimuth by the nearest obstacle . . . should not exceed 30 degrees, and the true bearing of the obstacle from the gauge should be carefully measured and noted in the register." In plain language, the Meteorological Office recommends that the gauge be twice the distance from the obstacle as the height of the object in question, though it must be admitted that this is not always possible in small gardens. In a desire to avoid obstruction, we must avoid the other extreme. The site must not be too exposed, nor should it be on sloping ground.

The rain-gauge is best fixed into the ground by fitting its base accurately into a hole lined with cement-concrete. Meteorological Office gauges are frequently made with splayed bases, and if these are firmly embedded in cement, it is quite impossible for them to blow over.

All gauges should have a capacity of 4 inches at least, for it is possible that rain sufficient to fill a gauge of this size may fall in the British Isles in 24 hours. Indeed, falls of as much as 9 and 10 inches have been known to take place in this country.

We will now suppose that a fall of rain has taken place. We visit the gauge, which, we will assume, is marked in inches, at 9 a.m. G.M.T.,[1] the usual hour for making such observations. We remove the funnel, laying it carefully aside, take out the inner can or bottle, as the case may be, and pour the contents into the Camden measure-glass. Each mark on the glass, except the bottom one, indicates one hundredth of an inch. The bottom one indicates half a hundredth. When small amounts of rain have fallen, this bottom mark is of importance, because if the water stands above it, the amount is recorded as 0·01 inch and the day is known as a "rain day." If the water does not reach the mark, the record becomes "trace."

We will assume, however, that the fall has been a heavy one, and that the water has reached the twenty-seventh mark. This is recorded as 0·27 (each mark being a hundredth of an inch). If we find there is more water in the gauge than fills the measure-glass (capacity 0·50 inch), we proceed to fill it accurately as many times as it is possible, and measure the fraction over also. Thus, if there is sufficient water to fill the measure-glass three times and to fill it for the fourth time to the mark 0·23, the recorded fall will be $3 \times 0{\cdot}50 + 0{\cdot}23$, i.e. 1·73 inches. A similar procedure with a measure-glass graduated in millimetres and tenths enables a record to be made in that case also.

When snow falls instead of rain, the method of measurement is modified slightly in one of two ways. The first method is to remove the funnel of the gauge, taking care not to lose any of the snow retained in it, and to take it and the bottle or can near to a fire, so that the whole of the snow may be melted. The water is then measured in the usual way. The second way is to measure say ½ inch of warm water in the measure-glass, and pour it over the snow in the funnel so that it melts and runs down the tube into the bottle below. The actual rainfall is then the whole amount measured less the amount added to melt the snow. Hail may be dealt with in the same way.

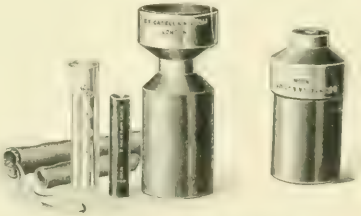

FIG. 4.—LIVINGSTONE PORTABLE RAIN-GAUGE.

When positions are chosen for rain-gauges where they cannot be visited daily, it is necessary to employ a mountain rain-gauge such as the Bradford. The Bradford is a Snowdon gauge modified to suit the purpose for which it is intended. Its funnel is 5 inches in diameter, but the inner can is made to contain from 12 to 30 inches according to the rainfall of the district in which the gauge is to be used. This gauge measures, of course, the monthly rainfall, if the readings are made once a month (usually at 9 a.m. on the first of the month). Before measuring the quantity of water in the usual way with the measure-glass, the approximate amount of water is ascertained by means of a graduated dip-rod. This checks the more accurate determination of the amount by means of the measure-glass, and prevents any uncertainty as to the number of times it has had to be successively filled.

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[1] Greenwich Mean Time. In official observations, time is reckoned from midnight in 24-hour periods; 9 a.m. being 9 hours, and 9 p.m. 21 hours, and so on. "Summer time" is ignored.

For explorers and travellers there is a portable rain-gauge. This has a funnel of diameter 3 inches, and every part is small in proportion for the sake of portability. A good example of this type is the Livingstone Portable Rain-gauge made on the same lines as that originally supplied to Dr. Livingstone for use in his African travels.[1]

Before concluding this section, it may be well to state briefly how the markings on the measure-glasses are calculated. Since " an inch of rain " means a cubic inch of water on a square inch of surface, we proceed to calculate as follows. Let our rain-gauge have a diameter of 8 inches. If it be filled with water to the height of 1 inch, the volume of water in it is $\pi r^2 h$ ($r =$ radius; $h =$ height), i.e. $\pi \times 4^2 \times 1 = 16\pi = 50{\cdot}265$ cubic inches. Now, when this amount of water is poured into a Camden measure-glass, the measure-glass has to record 1 inch. Since the Camden when filled holds $\frac{1}{2}$ inch only, its volume must be 25·132 cubic inches. If R be its radius and H the height that records $\frac{1}{2}$ inch of rain, $\pi R^2 H$ must equal 25·132 cubic inches. R is usually $1\frac{1}{4}$ inches, $\therefore H = 5{\cdot}12$ inches. A measure-glass of $2\frac{1}{2}$ inches diameter, when filled to this height with water from an 8-inch gauge, " records $\frac{1}{2}$ inch of rain." It is an easy matter now to calculate the heights which record different hundredths of an inch.

NOTE.—Further information on rain-gauges may be obtained in *The Principles of Aerography*, by Alexander McAdie (Harrap, 21*s.* net); *Meteorology for All*, by D. W. Horner (Witherby, 6*s.* net); and *Meteorology: Practical and Applied*, by Sir John Moore (Rebman, 10*s.* 6*d.* net).

Lord Lister

APRIL 5, 1827—FEBRUARY 10, 1912

The Discoverer of the Antiseptic System of Surgery

By Edward Cahen, A.R.C.S., F.I.C.

THE rise of industrialism in the nineteenth century, with the consequent migration of the artisans from the country to the factories in the great towns, led to overcrowding in the hospitals; partly on account of the decreased vitality and power of resistance to disease, and partly because of the increased number of accidents inseparable from such an existence. " Disease is the shadow of death that clouds the life of man. When Lister was born this shadow was probably deeper than at any other time; so deep, in fact, that it threatened the very existence of industrial populations "[2] for the reasons just given. It was to dispel this shadow that Lister was born in the spring of 1827, of Quaker parents, who were then residing at West Ham. His father was a scientist and a Fellow of the Royal Society, and had made the first achromatic microscope, and it was from him that young Lister learnt to appreciate this instrument of research, which led to such important results in his later work.

He received his early education at a Quaker school, and then passed to University College, Gower Street, in 1844. Medical training was then just beginning to emerge from the dark ages of body-snatching and apprenticeship. In this school, which has turned out so many distinguished men, he came into contact with Thomas Graham, from whom he received a good grounding in chemistry, and William Sharpey, the Professor of Physiology, who awakened in him a keen desire for research. In 1852 he published, with some very fine drawings he had made in illustration, his first piece of research, which dealt with the mechanism of the iris of the eye. In time he became dresser and later house surgeon to Eric Erichson, the author of one of the most famous textbooks on surgery in the English language. In this position he came across " hospital gangrene " and all its horrors for the first time. The general practice of the day was to burn away the affected parts with caustic, but the suffering and toll of death remained unabated; there was a very generally accepted view that it was the oxygen of the air which burnt up the tissues and gave rise to the inflammatory conditions observed. Lister discovered the true reason while examining the diseased tissues with his microscope. He concluded that the cause of the trouble might be " in the form of some kind of fungus."

In the same year that his first research was published he was sent with a letter of introduction to James Syme, the Professor of Clinical Surgery in Edinburgh, and the greatest surgeon of his day. This visit resulted in his remaining for twenty-five years in the North, and when he returned to London it was with a world-wide reputation, and to convert his native city to his system of antiseptic surgery. He held various posts under Syme in the Edinburgh Infirmary, and four years later married Syme's daughter; thus it came to pass that he gained from both father and father-in-law the knowledge by which he was able to revolutionise the art of surgery.

There he studied the reaction of living tissue to attack, and came to the conclusion which was the basis of his great discovery, that the lack of vitality after an injury made the wounded flesh a prey to attack from some agent as yet unknown.

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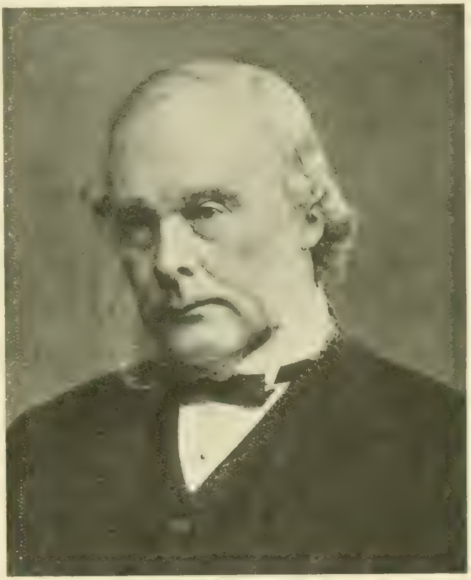
[1] The illustration of this instrument is lent by Messrs. C. F. Casella, London.

[2] G. T. Wrench, M.D.

In 1860 he was appointed Professor of Clinical Surgery in the University of Glasgow, but it was not till a year later that he became surgeon to the Infirmary in that city. Here again he came into contact with those terrible conditions pertaining to public hospitals, their fetid odour, the look of suffering, and the fear of death. It was truly said at the time that the victim of a street accident stood a better chance of recovery outside these "houses of death" than in their wards. The discovery of the anæsthetic properties of chloroform by Sir James Simpson in 1847 had in a sense made matters worse, for it had led to more operations, and consequently more deaths from hospital gangrene. Only about 60 per cent. of the patients of those days ever recovered from an operation. The Glasgow wards were no better than the others, and although Lister introduced both air and cleanliness into them, the death roll was not appreciably diminished. Accordingly he proceeded to search the literature of three lands, and in 1865 came across Pasteur's work, and the great discovery of the existence of microbes in the dust of the air, with which readers of DISCOVERY [1] will be familiar. He immediately connected the results obtained by Pasteur with his own early work on the paralysis of the tissues when injured. He concluded that the tissues, when their protective vitality was temporarily wanting, became the prey of the micro-organisms just as though they were dead and in the proper condition for putrefaction to set in. This explained why it was putrefaction only began in cases of compound fracture where the skin was broken, and not in cases of simple fracture where the skin was not cut. Thus it came about that Lister, through his use of the microscope, was the only one who, on hearing of Pasteur's discovery, was able to grasp its full meaning. He had a perfectly clear vision of the microbes attacking the apparently dead tissues, which through their temporary lack of vitality were unable to resist. The problem was now a simple one to be solved by simple methods. Kill the microbe and allow the tissues to regain their vitality and power of resistance. The wounds, whether accidental or the result of surgical interference, would then heal up quickly. This is what Lister set out to do. His attention had been attracted to an experiment made by the City authorities at Carlisle in destroying the odour of their sewage by means of carbolic acid. It struck him that this might be just the agent for his purpose. The carbolic acid of that day, it must be noted, was very impure, being full of tarry matter and very insoluble in water. The first experiment was made in 1866 on a small boy, who was brought in from a street accident with a compound fracture of his leg. Cleaned and dressed with carbolic, the wound healed, and the boy was soon able to walk again. Having thus found out how to deal with such cases, and having successfully treated many of them, Lister passed on to the consideration of cases of chronic abscess, which more often than not proved fatal on operation. Here again he succeeded, where others had failed, by his firm belief in the germ theory, and by his careful exclusion of all contamination from the wound by his carbolic dressings. It was an age of controversy; no one could understand why it was that the mortality in hospital was so much greater than in the rural districts; there was a discussion as to the best form of ligature to employ. Lister wisely kept aloof from all controversy, and set to work to find out these things for himself by means of numerous experiments. He reduced the mortality in his wards at Glasgow by the simple expedient of washing everything—the wound, the hands of the operator, and the instruments used—in carbolic solution. He found that catgut sterilised in carbolic acid was by far the best ligature to use, but for twelve years he kept an open mind regarding the merits of the various catguts obtainable. He even paid visits to the factories where they were produced. Finally he fixed upon the one in use to this day.



LORD LISTER.

By kind permission of Messrs. Elliott & Fry.

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[1] DISCOVERY, November 1920, p. 330.

It was not till 1869, soon after he had gone to Edinburgh to fill the position of his father-in-law (who had retired through illness), that he finally decided to publish his antiseptic system, thinking that it should no longer be withheld from suffering humanity; as he himself expressed it: "The antiseptic system has now been in operation sufficiently long to enable us to form a fair estimate of its influence upon the salubrity of a hospital. Its effects upon the wards lately under my care in the Glasgow Infirmary were in the highest degree beneficial, converting them from some of the most unhealthy in the kingdom into models of healthiness. The interests of the public demand that this striking change should be generally known."

Like all innovators, Lister was immediately attacked from all sides, and more especially by the surgeons of his own land. It was seven years before the surgeons of London finally capitulated, and only then when he came down from the North personally to demonstrate his system to the unbelievers. The controversy centres round the germ theory of Pasteur, and Lister met with just the same trouble from his colleagues in England as the great Frenchman was encountering in France. He even went so far as to repeat some of Pasteur's experiments with improvements of his own, and in every case obtained results which confirmed the conclusions arrived at by Pasteur regarding the origin of putrefaction and disease. As is so often the case, the recognition which was denied hm by his own countrymen was accorded him by the surgeons of foreign countries, and more especially by those of Germany and Denmark. In 1875 the Congress of German Surgeons met in Berlin, and sent him an invitation to visit Germany, an invitation which he accepted in the summer of that year, making a triumphal progress from town to town.

The hostility of the London surgeons to the new system was galling to Lister, not because of any feeling of personal slight, but because he did not like to think of all the suffering still being endured by patients from whom the advantages of the new system were being wilfully withheld. It was on this account that in 1877 he left Edinburgh and accepted a much inferior post as Professor of Clinical Surgery at King's College, London. Lister came South to fight for his system, and it was not long before the results he obtained made further fight unnecessary. The London surgeons gave in; the victory was gained finally; but the triumph did not come till two years later when he was acclaimed by the International Congress of Medical Science in Amsterdam.

Lister was a man of extreme simplicity, and possessed of a serenity that was no doubt inherited from his Quaker ancestors. As a surgeon he was bold with the boldness born of certainty. His outlook on life was philosophical, and his system of antiseptic surgery was the outcome of his view of life. It was only after countless experiments that he finally fixed upon the most suitable dressing to ensure the best results. That dressing, a mercury-zinc-cyanide gauze, is still in use to-day.

NOTE.—The reader will find *Lord Lister: His Life and Work* by G. T. Wrench, M.D. (Lond.) (Fisher Unwin, 1913), most interesting and readable.

Books of the Month[1]

The following is our monthly selection of books which we commend to the notice of our readers.

And Even Now. By MAX BEERBOHM. (Heinemann, 7s. 6d.)

Twenty recent essays delightfully written.

Winsome Winnie and other Nonsense Novels. By STEPHEN LEACOCK. (John Lane, 5s.)

Excellent skits on the most usual plots of novels.

In the Mountains. ANONYMOUS. (Macmillan, 7s. 6d.)

Essays on Books. By A. CLUTTON-BROCK. (Methuen, 6s.)

The Art of Letters. By ROBERT LYND. (Fisher Unwin, 15s.)

A History of Scotland from the Roman Evacuation to the Disruption. By PROF. C. S. TERRY. (Cambridge University Press, 20s.)

English Wayfaring Life in the Middle Ages (XIVth Century). By J. J. JUSSERAND. Translated by LUCY TOULMIN SMITH. (Fisher Unwin, 25s.)

The World of Sound. By PROF. SIR WILLIAM BRAGG, K.B.E., F.R.S. (Geo. Bell, 6s.)

The Christmas lectures of last year at the Royal Institution.

Instinct and the Unconscious. A contribution to a Biological Theory of the Psycho-Neuroses. By W. H. R. RIVERS, M.D., D.Sc., F.R.S. (Cambridge University Press, 16s.)

Secrets of Earth and Sea. By SIR RAY LANKESTER, K.C.B., F.R.S. (Methuen, 8s. 6d.)

A delightful book of non-technical science.

The Place Names of Northumberland and Durham. By PROF. ALLEN MAWER. (Cambridge University Press, 20s.)

An important volume of the Cambridge Archæological and Ethnological Series dealing with the origins of the place-names of two counties.

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[1] Short accounts of some of these and of other books will be given next month.

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Editorial Notes

THE possibilities of a trans-Pacific flight has been discussed by two writers in a recent number of the periodical *Aviation*. A look at the map will show how much longer a flight from, say, California to Japan is than one from Canada to England. There are several likely routes that might be tried in attempting to make such a flight. There is, of course, direct flight from America to Asia over about 4,500 miles of sea. A halt might be made, however, at a suitable intermediate spot such as Honolulu in the Sandwich Islands. In this case the direct water-stretches would be replaced by two of about 2,100 and 3,400 miles. A third possible route would be to fly round the American and Asiatic coasts, the only stretch of sea to be flown over then being the short distance across Bering Strait. This would involve a flight over a distance from 6,000 to 8,000 miles, depending upon where the flight commenced and terminated.

* * * * *

At the present time the record flight of a lighter-than-air machine is that of a Zeppelin during the war which flew 4,000 miles in 100 hours, and of a heavier-than-air machine that of the Vickers-Vimy which crossed from Newfoundland to Ireland, a distance of about 1,900 miles. Considering both radius of action and reliability, the authors consider that the rigid airship stands first, the non-rigid second, and the seaplane third. They have worked out five principal routes after considering the lengths of the stages of the flight, meteorological conditions, and facilities for landing, repair, and re-fuelling. Each route possesses certain advantages as regards the type of machine in which the flight is proposed. The conclusion of the matter is that a rigid airship should be able to do the flight to-day without a stop; a heavier-than-air machine, however, could do it also, but only by stopping for re-fuelling.

* * * * *

It is now well known that Colorado is the chief place on the earth's surface at which radium may be found. The other and better-known sources, namely, the mines of Bohemia, Saxony, and Cornwall, contain small quantities of ore compared with the amount found near Denver. The ore there is called carnotite, and has been mined for many years for the substance vanadium (a constituent of certain steels) which it also contains. The size of the deposits varies from a few pounds to many tons, and altogether in the area explored there is estimated to be about 100,000 tons of ore. The quantity of radium in this mass may be calculated from the percentage of uranium (about 1·5 per cent.) which it contains. It is about 15 ounces avoirdupois, or 425 grams. This may not seem a great amount, but it is about 425 times more than most research-workers have ever seen or handled. Radium is one of the few things which has not advanced very much in price since 1914, but its advance in the twelve years before the war was so great that it may have felt it had already done quite enough in that particular way. In 1902 the price was 5*s.* a milligram—i.e. £250 per gram—next year it was £300 per gram, and in 1904 £1,000. The present price is about £25,000. In spite of this the demand for it is steadily increasing. It is to this American source of supply that research-workers, hospitals, and all who need radium must turn for the material itself; it is harder, however, to indicate the source they should seek to obtain the money to pay for it.

American chemists have succeeded in preparing leather from the inner membranes and the outer skins of sharks. As the yearly catch of these fish may be as high as ten thousand, an industry of some importance has been started. It seems that the tanning of the shark-skins was a great difficulty, as this could not be accomplished by the processes usually employed. Some ingenious chemist found out, however, that the outer skin could be separated into two layers. The inner one was a leather of good quality, and the outer, which was very hard, tough, and waterproof, was found suitable for soleing boots and shoes. The lining of the shark's inside is found suitable for gloves and fancy goods. Altogether, then, the shark has been found distinctly useful in America.

* * * * *

From Canada there comes a book in which the question, Has the North Pole been discovered? is discussed. The less sophisticated of us in this country believe that Commander Peary got to the Pole and that Captain Cook did not. The author, Mr. T. F. Hall, formerly a captain in the American Merchant Service and past member of the Nebraska legislature, has been investigating this point and has begun to wonder. Indeed, he comes to the view that there is no conclusive evidence that either Peary or Cook reached the Pole. He began his investigations with full faith in Peary, but evidently he has not continued till this faith has been fully restored to him. He thinks that Peary's different accounts of the journey are inconsistent, and are contradicted on essential points by those of the negro who was his companion; that the speeds claimed by Peary in his last journeys are impossible; that some of the photographs, from the very look of them, could not have been taken at the latitudes claimed for them, and so on. It is a pity that this book did not appear in Peary's lifetime. A gramophonic record of Peary's remarks on reading a review of it by Captain Cook (were he alive too) would have been highly interesting and no doubt instructive. This "doubting Thomas" attitude is typical of to-day, when the maximum intellectual satisfaction seems to be attained by many only when they have perfectly negative opinions on every subject of discussion except eating, drinking, and the weather. The question, however, may be safely left to American geographers.

* * * * *

An important oil-well has recently been located in the North-West Territory of Canada. Optimists think it may develop into the largest oilfield in the Empire—perhaps even in the world. The site was chosen in 1914 by a party of English geologists on behalf of a Canadian syndicate, but the war, difficulties of transportation, and other causes have delayed matters. The well is situated on the banks of the Mackenzie River within a few miles of the Arctic circle. It is about 1,000 miles N.N.W. from Edmonton, the capital of Alberta, and no less than 1,300 miles' journey by water beyond the northern limit of the railroads. The actual drilling did not commence till the spring of this year. At a depth of 800 feet in the first test well a large quantity of high-grade oil was struck, and it is expected that the well will produce several thousands of barrels of oil per day.

The long distance from civilisation, the severity of the climate, and other causes are holding up the work during the winter, but in next spring great hopes are centred on what a geologist who has been out there describes as "the biggest oilfield in the world."

* * * * *

The question of the age at which rubber trees are likely to become exhausted is one that is raised from time to time; it has so far not been satisfactorily answered. The Rubber Growers' Association recently received a communication from a company showing that its agents in the Federated Malay States had reported that a large number of estates were obtaining a reduced crop from old rubber trees, and inquiring whether any statistics were available on the subject. Assuming that yields fell off at a certain age, the company was anxious to know at what age this took place, and the extent of the failure to yield. It is admitted that there do not appear to be any statistics bearing on the question.

* * * * *

A number of members of the committee who have had the matter under investigation have been unable to collect any evidence to show that there is a falling off in yields owing to the increasing age of the trees. The decreased yields are in a large measure, in the past, due to such causes as over-tapping and to insufficient time being allowed for bark renewal. They consider that better conservation of bark and lighter tapping, coupled with cultivation of the soil and the careful nursing of the trees, will prove beneficial. Provided trees have not been affected with disease, they should regain their former latex-yielding qualities. There is every reason to believe that the yield increases with the advancing age of the tree.

* * * * *

The subject is one which is of the first importance to the industry. There certainly exist several of the trees planted in the Botanical Gardens at Ceylon, which are forty-four years of age and are still yielding rubber freely; but these are not grown under estate conditions. Statistics of yields from old rubber would be an immense advantage. Generally speaking, however, it may be stated that the oldest planted trees, if they have been properly treated, show little sign of any failure, but continue yielding latex.

* * * * *

An American magazine has recently published a note on dry-rot which may be new to many readers. The term is loosely applied to any kind of decay in wood, for wood which is kept sufficiently wet cannot decay. In the more limited sense, however, the term applies only to the work of a certain house fungus, *Merulius lachrymans*, which is frequently found growing in wood without any apparent supply of moisture. It cannot infect thoroughly dry wood, however, but, if it obtains sufficient moisture to germinate, it can make its way a very long distance into dry timber because it draws the water necessary for existence from the supply through a conduit system of slender, minutely-porous strands. Wood in the advanced stage of dry-rot is shrunken, yellow, or brown in colour, and filled with radial and longitudinal shrinkage cracks roughly forming cubes. Not only furniture but also logs in storage may become infected. Hard woods are more commonly immune than soft.

* * * * *

English books seem very scarce at various places on the Continent. A correspondent writing from Louvain says, " I have been to-day to the library here to see what books there are on the electrical theory of matter, and I was astonished to find there was none. Surely it is unfortunate that in all the books which England has collected and sent over here there should be none whatever representing English scientific thought and achievement. Thomson, Rutherford, Soddy, Ramsay, and Kelvin ought surely to be represented." We agree. A letter recently appeared in *Nature* on the same topic from a correspondent in Eastern Galicia. The writer declared that in the libraries of Warsaw, Lwów, and Krakow the English books could be counted on the fingers of the hands, and English periodicals simply were not there at all. It is well to know that the Anglo-American University Library of Central Europe is engaging itself in supplying this unfortunate deficiency. A little goes a very long way when periodicals and books are sent from this country to the stricken cities of the Continent.

* * * * *

I have received from Messrs. Bowes & Bowes, of Cambridge, a little book called *The Post-Prandial Proceedings of the Cavendish Society*. This book is a collection of topical verse on modern physics and other matters written by members of the Physics Research Society of the Cavendish Laboratory. It has been privately printed for sixteen years, but this, the fifth edition, is now published in the ordinary way for the first time. It will interest all those who are, or have been, connected either directly or in spirit with the splendid work on modern physical problems which has been one of the glories of Cambridge since the days of Clerk Maxwell.

* * * * *

Clerk Maxwell, who was quite a genuine poet in his day, wrote the first poem in the book, but undoubtedly the verses of A. A. R. read with the best swing. A part of one of his efforts may be quoted. Instead of saying in cold and technical prose that an α-ray is a material particle shot out by certain radioactive bodies at a speed of about one-twentieth of that of light, and carrying an electric charge of two, the poet says:

Air : "A Jovial Monk."

An alpha ray was I, contented with my lot
From Radium C
I was set free
And outwards I was shot
My speed I quickly reckoned
As I flew off through space
Ten thousand miles per second
Is not a trifling pace !
    For an alpha ray
    Goes a good long way
    In a short time *t*,
    As you easily see ;
    Though I don't know why
    My speed is so high
    Or why I bear a charge 2e."

Two further verses describe subsequent episodes in the short but exciting life of the α-ray. As is well known, an α-ray when it has slowed down behaves like an atom of helium ; it is also well known that several workers in radio-activity have had the uncommonly happy experience of winning the Nobel Prize (about £8,000), but that is prose ; here are the facts in verse, the α-ray is still speaking :

" But now I'm settled down, and move about
        quite slow ;
For I, alas,
Am helium gas
Since I got that dreadful blow.
But though I'm feeling sickly,
Still [illegible]
That I ran that race so quickly,
I've won a Nobel Prize.
    For an alpha ray
    Is a thing to pay,
    And a Nobel Prize
    One cannot despise,
    And Rutherford
    Has greatly scored
    As all the world now recognise."

Living Backwards

By J. S. Huxley, M.A.

Fellow of New College, Oxford

One of the great scientists of last century declared that Science was organised common sense. In a way it is; but in another way, how emphatically it is not! Perhaps we might say that it is a continual upsetting of the judgments and most firmly-held doctrines of common sense by an extension of common sense's own methods.

The motion of the earth round the sun, the mutability of species, the possibility of interchanging all the different forms of energy, the production of water by burning hydrogen in oxygen—how unlikely are all these facts, how much opposed to the common-sense ideas of common-sense people, but how undeniably true!

Common sense is content to generalise broadly and vaguely from just so much experience as necessity thrusts under its nose; science is for ever searching for more experience, which it may compare with what it already possesses. In its method of dealing with facts, science is but organised common sense; but in its method of collecting facts, it is common sense no longer. Common sense is content with every-day; but science is organised curiosity.

This part-antithesis between science and common sense is to-day being once more exemplified in relation to some of the most fundamental processes of life. To common sense it would seem obvious that development is a closed cycle, each stage leading forward in an inevitable series to the next. The fertilised germ becomes the embryo, the embryo becomes the young organism; youth leads to maturity, maturity to age, and age to death. That is the normal cycle in man and in the animals and plants with which common sense is familiar; it knows no facts that contradict the notion, and so the notion becomes a generalisation.

But science is not content with the familiar. An organism is an organism, whether it be a jelly-fish, a snail, or a dog; and all organisms are related. In some organisms the processes of development are not necessarily irreversible; and we are approaching the time when we shall be compelled to assert that these processes are fundamentally reversible, and that the irreversibility of our own life-history is only secondary.

Among marine animals there exists a curious group, the Tunicates, for long classified with the shell-fish until a study of their embryology revealed that they passed through a tadpole-like form, and that they were, in fact, poor relations of the Vertebrates, fixed by the head, having lost their eyes and ears, and feeding on microscopic particles brought in by a ciliary current. .One of them, Clavellina by name, was found by Driesch to possess the extraordinary faculty of returning to a simpler condition. The adult animal, pellucid, revealing to the microscope every detail of its elaborate anatomy—gill-slits, food-groove, stomach and intestine, liver, heart, minute brain—can, when damaged or placed in unfavourable conditions, altogether change its aspect. Its inhalant and exhalant orifices close, it gradually becomes opaque as it shrinks, and its various organs grow simpler and simpler, the cells of which they are composed losing their characteristic form, and becoming all approximately cubical. Finally, in the course of a week or two, the creature has become nothing more than an opaque white ball, covered with a single layer of epithelium; the internal organs are reduced to a few closed vesicles, and the space between them and the skin is packed tight with the blood-corpuscles. If now replaced in pure sea-water, it will retrace its upward development and become a normal individual again, perfect, but smaller, since a certain amount of material has been used up in the metamorphoses. The animal has been experimentally made to repeat this reversal and subsequent blossoming-out three times; and if it could be supplied with enough food to bring it up to its original size (unfortunately it is difficult to feed in the laboratory), it could no doubt continue to do so indefinitely. Such a process, which we may style dedifferentiation followed by redifferentiation, is clear evidence of the possibility of reversing development.

A different type of reversal is seen in many common flat-worms and sea-anemones. The Planarian flat-worms are among the simplest forms of three-layered animals. None the less, they have a sufficiently complex organisation, with brain-ganglion and nerve-cords, prehensile proboscis, branched digestive and excretory systems, simple eyes, and very elaborate reproductive organs. The sea-anemones are, of course, highly organised polyps—two-layered creatures, with radial symmetry, a circle of tentacles and a central cavity divided up by a number of strengthening partitions.

If one of these animals is starved, it does not die after losing a quite small amount of weight, as does a man, but gets smaller and smaller, saving itself from death by feeding upon itself. Sea-anemones several inches long have been made to shrink until they were no longer visible to the naked eye.

It is, however, the flat-worms which have been most thoroughly investigated. Some years ago, it was pointed out that a flat-worm which has been much reduced in size by starvation comes to resemble similar-sized young individuals of the species in all details of shape and proportion. Later, Professor Child, of Chicago, went further and showed that these reduced worms were young, not only in appearance, but in behaviour and physiological working too. They were, in fact, young in all essentials, and if food was given them, would once more grow up into normal adults. By means of alternately feeding and starving a single worm, Child was able to keep it within prescribed limits of size and of physiological age, while other individuals of the same brood had given rise to eighteen generations—a period which, translated into human terms, would take us back to Chaucer's time. The process could apparently have been indefinitely continued, but the Professor had sufficiently proved his point, and turned to other problems.

So the *Elixir Vitæ* has been found at last, and revealed in startling simplicity as enforced periodic starvation. Unfortunately, it is not a panacea, for it does not work with any organism higher in the scale than a flat-worm. . . . Ironical Fate !

There remains to be noticed another very curious form of reversal, which is interesting on account of the light it throws, in conjunction with the other processes we have been considering, on happenings in the history of the higher animals and of man himself.

Perophora is the name given to an Ascidian nearly related to Clavellina, but consisting of a series of very small green individuals, springing at more or less regular intervals from a creeping tube or stolon filled with blood, much after the fashion of strawberry plants along a runner. When this animal is placed in unfavourable conditions, it begins to shrink in exactly the same way as Clavellina, but instead of becoming a dense opaque ball, it grows smaller and smaller, and finally ceases to exist at all, having been completely resorbed into the stolon.

When this curious process is investigated, it is found that the various organs of the body become smaller, owing to their component cells successively leaving their places in the tissue and passing out as free units into the blood-stream. It is as if a house were to unbuild itself, the bricks flying out of their places in the walls, and the rooms gradually shrinking until nothing was left but a courtyard filled with loose brick-heaps.

Through all this elaborate unbuilding, the stolon remains perfectly normal, and may even grow. It would appear, therefore, that the individual proper is more easily affected by adverse conditions than is the stolon, and that this differential susceptibility, as we may call it, leads to the reversal of development in one part only of the whole organic system.

This is borne out by the fact that when the same system is kept in the best possible conditions, save for the fact that it is starved, it is the individual which absorbs and feeds on the stolon. In brief, in such a system, one part will be dominant ; and we can give dominance to one or to the other by varying the conditions.

Differential susceptibility is a universal phenomenon in biology ; for, in fact, what we imply by the term is simply that the parts of an organism are not all alike in their sensitiveness to external agencies.

When correlated with another fact in biology, however, it becomes of great significance. This other fact is the existence of what have been called axial gradients in the organisation of animals and plants, persisting often throughout life, but always existing during development.

By an axial gradient is meant a succession of parts from one end to the other of the main axis of a living organism, each part being successively a little less active in its metabolism, its general chemical reactions, than the one before. For instance, in a Planarian, or again in an embryo mammal, it would appear that the head is the most active region, the region where metabolism is at its quickest, and that as we proceed towards the tail, the rate of metabolism (using the word in its most general sense) becomes less and less. This conception again we owe to Professor Child. Into its details we cannot here enter ; it must suffice to look at some of its consequences.

Other things being equal, we would expect that a piece of machinery which is working quickly will be more damaged when an iron bar, say, is thrust into its midst than if it were working slowly. The analogy seems to hold for organisms. Poisons, whether narcotics, or those that stop oxidation, or acids, or mercury salts, when administered in such great dilution as not to kill but only to damage, act first and most strongly on the more active parts of the organism. Or if their strength is such as to kill after several hours only, the more active parts will die first, and death will creep down the axial gradient.

It follows that we should be able to find a dilution of poison which will affect the more active parts alone, and leave the less active parts to all intents and purposes undamaged.

This has been done. If, for instance, when a developing egg of a marine worm such as Chætopterus is placed in a very dilute potassium cyanide solution, the apical region of the larva, with its little sense-organ and tuft of cilia, is acted upon and fails to grow to the normal size. The hind-region of the body also, which is preparing for active growth into the trunk of the worm, and is found to start dying as quickly as the " head " region in dilute poisons, is reduced in the same way. The middle region of the body, however, is not affected ; and since there is a definite amount of yolk in the egg, available for the embryo's first period of growth, it seizes upon what the head and tail regions have not been able to profit by, and becomes not merely relatively, but also absolutely larger.

We thus see that a part possessing more active metabolism has in normal circumstances a first call upon the available food supply; it is also, however, more susceptible to harmful agencies, so that these, acting in certain intensities, upset the relative powers of the various parts to utilise food supply.

Normally, the proper balance of any organism is maintained by the interaction of its different parts, struggling for food, stimulating or depressing one another, embarking on overgrowth, or being reduced by resorption. Indeed, the organism in a quite real sense *is* the interaction of its parts, and in no sense merely their sum. The form, the rate of growth, the actions, the span of life itself—all are determined by the interaction of the parts of the incredibly complex self-regulating mechanism.

The rôle of the dominant region in this flying play of forces is of extraordinary importance. Again the Planarians will illustrate the principle for us. These flat-worms have a remarkable power of regeneration: the body may be chopped up into pieces, and each piece may reorganise itself into a new whole. Each piece may, but does not always do so: this depends on the age and condition of the original animal, and on the external environment. Now two things are noticeable. If regeneration is to occur, the first part to form will always be the head, the dominant region which in normal development also is first laid down; and secondly, the organs of the piece will only be reorganised if a head is formed. The most prominent of these in the central region of the body is the pharynx.

If an animal is cut in two behind the pharynx, the hinder half may form a head, or it may not. If it does, a pharynx will shortly afterwards appear in its proper relative position; if it does not, no pharynx will arise.

We may say that in animals capable of total regeneration, like Planarians, the tissues when cut will respond by forming a new dominant region; but when a dominant region has once been formed, they react by forming the various organs of the body in their due relation along the axial gradient. The working of the living substance of the species is thus altered under the influence of the controlling dominant region; but when this is removed, as by a cut, any region of it is capable of remodelling itself into a fresh dominant region.

This potential equivalence of all regions ceases to exist in higher forms, but none the less the dominant region exerts a profound control over the rest of the system. If, for instance, the limb of a young mammal such as a rabbit is exposed to X-rays of a certain intensity, it will develop into a small and stunted thing. But if the head be exposed to X-rays, not only will the head grow up stunted, but the whole of the rest of the body, though shielded from the effect of the X-rays, will be stunted too. The brain is the "dominant region" of the mammal, and general damage to it causes impairment of function in all the members.

Indeed, in the highest organisms, and more particularly in man, the whole creature may with propriety be thought of as consisting of two main parts—the conscious mind and the non-conscious nerve-centres in the brain on the one hand, and on the other the whole of the rest of the body, which is but the brain's servant and box of tools.

But even within the nervous system and within the mind, the parts are built up into a hierarchy of dominant and subordinate.

It was Hughlings Jackson who first gave this idea full weight, and in our own day Head especially has upheld and illuminated it.

The conscious centres of will and attention are dominant over unconscious centres in the brain, and these again over reflex centres in the spinal cord. Not only this, but education and mental and moral growth mean nothing else but a subordination of the will and the attention to a changing series of ideas, which rises (if the education is good, the mental development a true one) in a scale from the simple to the complex and general, from the instinctive to the reasoned, from the selfish to the altruistic. Each of these ideas represents a period of our life, a stage in our mental development, and is associated with definite past happenings, with actual events and moods and thoughts and wishes. . . .

"But what" (I can hear the reader say)—"what is all this about? What connection has it with living backwards?"

Its bearing upon the problem is this. Reversal of development led us on to resorption, resorption introduced us to the idea of differential susceptibility, and that again to systems built up as a hierarchy of dominant and subordinate parts.

But these, too, will show differential susceptibility; and so may prove capable of reversal of dominance. And, as a matter of fact, it comes about that even in the most highly-organised and complex system of all, in the system that underlies mind, such reversals of development may happen. It is not often that they happen; but the phenomenon is now well known, and goes by the name of "mental regression." Here the patient, as a result of "shell-shock" or other form of neurasthenia, reverts mentally to a younger condition. In the case-records given by Nicoll, grown men behaved like boys of five or ten, played childish games, became dependent on their nurses like any child, and actually lived in the world of associations and memories they happened to have grown through in boyhood.

The most remarkable case of all has not, I believe, been put on record, but has been mentioned in public lectures by Dr. McDougall and Dr. Hadfield. An Australian soldier, already suffering from shell-shock, received a severe fright. As a result, the whole of his adult personality disappeared, and he became an infant—the mind of an infant in the body of a man. He could not talk properly, he could not walk properly, and, most amazing of all, he could not take any food but milk.

Gradually he grew up again, retracing in a year the mental development of a lifetime, and, on returning to his native country, has become, it appears, a normal adult being again.

Such mental regression differs of course from the regression of Perophora, in that the physical basis of the mental processes, the nerve-cells and fibres, are not resorbed or dedifferentiated during the backward passage; they simply lie fallow, rendered somehow unavailable for the passage of nervous activity. But in other ways the processes are essentially the same.

As new conditions rise and confront the growing mind (and minds may grow throughout life), the will must bend itself to adapting the mind to meet them. We all know what pain and grief this may be, and how readily we turn to distraction, or to memory, or to an ideal or an imaginary future to escape for a time from the struggle.

When present conditions grow difficult, as in war, or in grief or worry, it becomes harder and harder for the will to accomplish its proper task, more and more tempting for the mind to slip away to its imagined or remembered happiness. But this is differential susceptibility; and after a time, in people of certain temperaments, the strain on the higher, controlling centres gets greater and greater until at last they are not able to function so well as the alternative system, the approaches to which have been thrown wide by the mind's longing and conscious dwelling upon it. At last the one sinks, the other rises, till they are at a common level; a fraction more, and the flood of nervous energy pours out from the world of the present into the world of its own desire, its own phantasy. When its own desire is represented by memories of a happy past, the mind reverts to that past. To be accurate, the will is liberated from its task of controlling the hated present, and turns to the simpler and slighter measure of control which it once had to exercise; and with that degree and form of will come flying back all the associations of the time when it was in power. When the desire of the tormented present will has simply been to abandon all control, without necessarily envisaging any particular past time as most desired, then apparently we have the complete return to the uncontrolled state of the infant.

There we must leave the subject. It is a fragmentary tale that I have been able to tell; but our knowledge is fragmentary. At least it will begin to give some idea of the new vistas that biology is opening up. We have at any rate been able to assure ourselves that life can run backward, that reversal of development is a fact. Further, we see that reversal may show itself in several forms. It may be compatible with health and with normal function throughout, as in the Planarians; or, though recovery from it may be possible, yet reversal itself is only accomplished by a change to a simpler non-functional state, in which the organism can tide over hard times, as in Clavellina; or it may be (for the individual concerned) a pathological process, resulting inevitably in death, as in Perophora; or, finally, it may affect the mind without affecting the body, as in mental regression.

Such facts, among many others, make us feel that we are on the verge of a control of living matter which will make even our control of inorganic matter seem unimportant. The biology of to-day will look to our descendants as the chemistry and physics of Boyle and his contemporaries look to us. And the results will not merely be capable of changing our environment; they will be capable of changing us—our constitutions, our very natures. Let us hope that the thought of that time and the rulers of that time will be better fitted to make use of those discoveries than are the thought and the rulers of our own time to make use of the power that discovery has already put into their hands!

The Discoveries in Crete

By George Glasgow, B.A.

(Concluded from January No., p. 11)

IX

Cretan religion differed from that of classical Greece in that the chief deity worshipped was a goddess, Mother Nature or Earth-Mother, some at least of whose characteristics we find embodied in the Rhea of Greek mythology. Matriarchal religion seems to have been specially characteristic of very early times; through it primitive man expressed his veneration of womanhood. The Cretan Mother Goddess holds an exalted position. She wields the supreme power over all Nature; is associated with doves, which symbolise her power in the air; is accompanied by lions, the strongest animals of the earth; brandishes snakes, that live under the earth. Among the various "cult objects," or ritualistic forms used in worship, found in her shrines are included representations of cows with calves, goats with suckling kids and the like.

There was a god as well as a goddess in Minoan religion, but he was of relatively little importance. Velchanos, the Cretan Zeus—if we may assume that the Minoan god was the original of this figure of the Greek legends—was represented as both the son and the husband of Mother Nature. He was suckled, so the tradition ran, by Amalthea the goat in the cave of Dikte, and brought up by his mother Rhea on the slopes of Mount Ida. His insignificance in comparison with the female deity appears from the fact that he was drawn on a smaller scale whenever represented in her company. The two deities probably constituted, as Mr. Hogarth has suggested, a "Double Monotheism"—a double godhead, that is, worshipped to the exclusion of all minor deities. If this was the case, the various Cretan prototypes of later Greek divinities must be regarded as variant forms of the Mother Goddess herself. Aphrodite, for instance, the goddess of Love, was worshipped generally in the Levant, being known in Canaan as Ashtaroth-Astarte, and in Egypt as Hathor; her Cretan name is unknown. The Greek Artemis, goddess of the Wild Beasts, was foreshadowed in the Cretan Dictynna.

One great difference between the Cretan and the Hellenic Zeus was that the Cretan Zeus was mortal, and was said to have died on Mount Juktas. The mortality of their gods was one of the striking conceptions which differentiated the Southern peoples of the Near East from the later Greeks, who came from the North. The Egyptian Osiris, for instance, could die, but not any of the Greek gods. The Cretan Mother Goddess is depicted on seal stones and rings dressed like an earthly queen, while Velchanos is seen descending from the heavens to the earth, a young warrior with a spear and an enormous shield.

Another difference between Cretan and classical Greek religion was that, as far as one can see, Cretan religion did not give rise to any great temples, nor did it leave behind any more substantial traces of its activity than the small figures of the Earth Goddess to whom I have referred. It may be sound to regard the palace of Knossos as itself a temple, and it is true that legend makes of Minos a High Priest as well as a King. There seems, however, to be little room for doubt that the only places set aside specifically for worship were small private shrines used for family worship. All the evidence tends to indicate that it was the family idea that predominated in Cretan worship. Private houses had their shrines, and the Knossian palace-temple itself had its lesser family shrines. These sanctuaries were always distinguished by a sort of sacred pillar, a sign which in Minoan art is often used as the only indication of a sacred place. There is an example of it on a fresco painting found at Knossos. Another emblem associated with the cult is that of sacred trees, which on rings and seal stones usually form the background for the *choros*, or dance. The actual dance, no doubt, would be performed in sacred groves.

Many cult-objects have been found in the shrines, the commonest being the mysterious Double Axe. The fact that this emblem was also specially associated with the Carian Zeus at Labraunda has led to a generally accepted theory that the Cretan "Labyrinth" corresponds to the Carian "Labraunda," or place of the "Labrus" or Double Axe; for the Knossian palace must have been, in fact, the chief seat of the cult.

Side by side with the Double Axe one finds the constantly-recurring sign of the Bull, an animal which was sacred not only because of its great physical strength, but also because of its use in sacrifice. A sarcophagus or coffin of terra-cotta, found at Hagia Triada, contains a picture of a sacrificial bull following a procession of women priests. In view of the prominence given to the Bull in Minoan worship, one need not seek very far for an explanation of the Cretan legend of the Minotaur, a monster half man, half bull, which lived in the labyrinth and exacted its human victims. Nor is it impossible that the dangerous and cruel sport of bull-fighting [1] formed part of the same cult. Bulls' heads were made in pottery and used as votive offerings, and were sometimes made of gold. The horns of the bull—Horns of Consecration—are found in shrines among ritual objects.

Cult-objects were usually of a rude and inartistic kind, a striking exception to the general rule being afforded by some brilliantly-coloured figures of ware which if it were modern would be called "faïence," belonging to the M.M. III period. Perhaps the best example of this ware is a group consisting of the Snake Goddess and her votaries, which was found by Sir Arthur Evans in 1903, and which was used in a shrine of the royal household.

There was a specially important element in Cretan religion reserved for the cult of the dead.

It is obvious, from the many tombs that have been excavated, that in very early times it was the practice to bury the body of the dead in a doubled-up position, the knees being drawn up to the breast. In later times the body was laid out at full length. It is not clear whether or not there was any particular significance in this choice of position. There were various kinds of tombs and graves, all of which were used contemporaneously, and of which, perhaps, the most interesting were the *tholoi*. The word *tholos* properly means a domed building or rotunda, and the particular kind of tomb to which it is applied is a vaulted chamber to which entrance is effected through an underground tunnel, or *dromos*. It is conceivable, indeed almost certain, that in form these *tholoi* were based upon the huts used—at some period—by the living. There are both round and square *tholoi* found in Crete. The *tholos* of Hagia Triada has a circular ground plan, while the Royal Tomb at Isopata and other elaborate tombs of the great palace-periods are rectangular. The principle of the tholos-tomb was most in use in Mycenæan times, on the mainland of Greece, where the " beehive tombs " almost all retained the original round formation. The hilly character of Crete led the people to cut out their *tholoi* in the side of the rocky hills, the *dromos*, or tunnel, in this case being driven into the hillside almost horizontally.

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[1] See DISCOVERY, August 1920, p. 240

Another style of grave was the shaft- or pit-grave, which consisted of a pit sunk into the ground, at the bottom of which was the grave itself, closed over with slabs of stone. Still another kind was a combination of the first two, and is known as the " pit-cave." This was made by first sinking a pit and then cutting out the tomb in the form of a side-recess from the bottom of the pit. A simpler form of burial, known as the " pot-burial," was effected by trussing up the body, placing it under an inverted jar, and then burying it in the earth. A sixth form was that of the simple grave, like our own. Cremation was not practised in Minoan times, although it was introduced into Crete from Greece in the Iron Age. Clay coffins were first used in the Middle Minoan period, being made in the form of deep boxes with sloping tops resembling the roofs of houses.

Such were the physical conditions of burial. We knew practically nothing of the cult of the dead until Sir Arthur Evans published some new and enlightening disclosures six years ago.[1] It was known before that the dead in their spacious tombs were honoured with gift-offerings, which included weapons, jewellery, and objects closely associated with them in their life; that food and drink offerings were made and coals of fire lighted, possibly with the naïve or symbolic object of cheering the traveller on his mysterious way. Now, however, a new series of tombs has been found at Isopata, one of which, called by Sir Arthur Evans " the Tomb of the Double Axes," is proved to be not only a tomb, but a shrine of the Minoan Great Mother. In this tomb were found libation vessels, including a *rhyton* (or drinking-cup) in the shape of a bull's head made of steatite, and a pair of double axes; the grave which received the body is cut out in the form of a double axe. " The cult of the dead," says Sir Arthur Evans, " is thus brought into direct relation with the divinity or divinities of the Double Axes, and we may infer that in the present tomb the mortal remains had been placed in some ceremonial manner under divine guardianship."

X

When Knossos fell, Crete ceased to be the preeminent power in the Near East. The island itself was overrun by military or naval adventurers, and the centre of Mediterranean life shifted over to the mainland of Greece, whence, indeed, those adventurers came. The striking thing, however, was that Cretan culture went with it, and neither for the last, nor probably for the first, time " the captive led captive her savage conqueror," as Horace wrote centuries afterwards. Crete stooped to conquer Greece, just as Greece in her turn stooped to conquer Rome.

The Cretans as a race were quite distinct from the contemporary inhabitants of Greece. Physical types were sharply divided by the shores of the mainland. The critical reader may ask: " Is it worth while to speculate as to the physical characteristics of a people which flourished 4,000 years ago, whose very existence was obscured by the Dark Age that comes before Greek history, and whose existence was not rediscovered until, so to speak, the other day? " And yet archæology works wonders. It is true that in this particular field, in which archæology is chiefly dependent upon portrait-paintings and bones, there is more controversy and less certitude than in the others; and that craniology, or the study of skulls, with their much-disputed classification into " brachycephalic " or broad-headed, " dolichocephalic " or long-headed, and " mesocephalic," midway between the two, is a fruitful source of confusion; that the " cephalic " index—that is, the breadth of the skull above the ears expressed in a percentage which gives the proportion of this breadth-measurement to the measurement of the length of the same skull from the forehead to the occiput—is a very poor index of anything at all. Still, there is ground for assuming that from the later Stone Age onwards the islands of the Ægean were mainly peopled by members of the " Mediterranean " race, small of stature, with oval faces, with perhaps rather long heads—if that means anything—

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[1] *Archæologia*, 2nd series, vol. xv, 1913–14.

with small hands and feet, with a dark complexion and with dark eyes and black curly hair.

According to Professor J. L. Myres in his *Dawn of History*,[1] the north-west quadrant of the Old World resolved itself racially into three belts, which were determined by geographical conditions. In the north were the pure white-skinned "Boreal" men of the Baltic basin; next came the sallow "Alpine" type; then the red-skinned "Mediterranean" man. The third was an intruder from the South, not far enough south for him to be a negro, but probably from the northern shores of Africa. His intrusion "formed part of a much larger convergence of animals and plants from the south and south-east into the colder, moister regions which have been released since the Ice Age closed." The limit of the movement seems to have been fixed by the shores of the mainland, because the lungs and constitution of the people concerned were unable to endure any further cold.

The establishment of the existence of the Mediterranean race has had, among other results, that of making it no longer possible, as was invariably the practice before Crete was excavated, of ascribing all obscure factors in the beginnings of Greece to a Phœnician origin. We now know, for instance, that the art of writing came from Crete, Phœnicia being the medium. We know now that Phœnicia was merely a late centre of the general Ægean civilisation, and was specifically called by the name because it was the best-known branch of the "red-skinned" race; for "Phœnikes" literally means "Red-skins," and in Homer Phœnix himself is a King of Crete and grandfather of Minos.

The Minoan people, then, formed part of the Mediterranean race. Their dress was much simpler than that of the classical Greeks. The men wore a short pair of drawers or a loin-cloth, the upper part of the body being bare as in the cup-bearer picture (January Discovery), a style emanating, as did the men themselves, from the warm lands south of the Mediterranean. Egyptian fresco-paintings reveal an almost exact analogy of type in the clothing and appearance of the Egyptians. Those who have a keen eye for the persistence of type may perhaps be interested to compare some of the forms of loin-cloth, as depicted on seal stones, with the *brakais*, or baggy breeches, still worn in Crete. Elders and officials apparently wore the added dignity of flowing cloaks. High-topped boots—again suggestive of those worn to-day—were in general use. Men wore their hair long as did the women, plaited and coiled up on the top of the head, thereby forming the only headdress that was used.

Minoan war-equipment was severely limited. Their only weapons were a long sword and a dagger, the latter of which is shown by pictures of clay figurines to have been carried inside the belt at the front. Their only armour of defence was a big shield of leather and a leather conical helmet. The shield was framed in a metal band, but had no handle or central boss; it was big enough to cover the body from head to foot, and it could be bent so as to protect both sides. It is represented in certain pictures in a curious 8-shape, pinched-in in the middle. The origin of this may have been that it was the practice to sling it over the left shoulder suspended by a strap, and for this purpose the figure-of-eight shape may have been convenient.

Horses apparently were used both in war and in hunting, although we have no pictures of them being ridden. The available evidence shows them only in the shafts of two-wheeled chariots. This accords well with Professor Sir William Ridgeway's observation (made far back in the eighties of last century) that in Homer the horse was driven only, and no bigger than our donkey. There is reason for thinking that the horses were imported, and imaginative people have recognised evidence of this in the fact that a seal stone has been found which shows a horse on board ship. Whether intentionally or merely from crudity of draughtsmanship, one is left in little doubt as to what mostly occupied the artist's mind when he fashioned this stone, for the horse covers three-quarters of the ship's length, and towers high above it, while the crew stand as high as the horse's knees.[2]

The women are readily distinguishable from the men in Cretan pictures by reason of their white skin, suggestive of a more secluded indoor life. They wore large shady hats, close-fitting, puffed-sleeved blouses, cut very low in front, and projecting upwards into a sort of peak at the back of the neck. They wore wide-flounced, richly-embroidered skirts like crinolines, and had belts like the men's. A French scholar, on first seeing some of the pictures representing Minoan women, was so taken by surprise that he exclaimed: "Mais ce sont des Parisiennes!"

Minoan women enjoyed a far more "advanced" status than did other primitive women. In the art of their day they are represented as appearing in public and unveiled; they took part in the bull-fighting at Knossos, and their apartments in the palace were marked out by their special luxury. The greatest glory for an Athenian woman of a later age was to be "as little mentioned as possible among men." Not so for the women of Crete. There may be significance in the fact that the Lycians of Asia Minor, who were colonists from Crete, made a practice of calling children by the mother's, not the father's, name.[1] If this was the case also in Minoan Crete itself, it may afford a possible explanation of the freedom enjoyed by Cretan women; for the practice of naming children after their mother instead of after their father is connected with states of society which have not yet evolved any definite ideas of marriage, and in which, as Herbert Spencer says, "The connection between mother and child is always certain, whereas the connection between father and child would sometimes be only inferable."

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[1] Pp. [illegible] Williams & Norgate, 1912.

[2] On the fascinating subject of the history of the horse, the reader should consult Sir W. Ridgeway's *Origin of the Thoroughbred Horse* (Cambridge University Press, 1905).

XI

Towards the end of the Minoan Age Cretan culture began to spread all over the Ægean, and extended to the mainland. Cretan vases are found as far north as Bœotia, and the many Cretan relics discovered in Mycenæan tombs were not all war-souvenirs; some of them, belonging to times before the fall of Knossos, were the peaceful product of Cretan workmen who had been induced by the Lords of Mycenæ to emigrate.

The men from the North who finally overthrew what we call the Minoan civilisation, became to some extent the repositories of Cretan tradition. They carried on a less splendid phase of Cretan civilisation, a phase which was distinguished by the name "Mycenæan." They had come to Greece from lands still further north, whence they had themselves been driven to seek new homes. They came down in successive waves of invasion, the men who formed the first wave being known as the "Achæans," the "yellow-haired Achæans" of Homer. It was they—so at least some authorities hold—who sacked Knossos, and who afterwards, during the thirteenth and twelfth centuries B.C., wandering about in search of adventure, became the terror of the whole Ægean. An Egyptian inscription of those times says: "The Isles were restless: disturbed among themselves."

Egypt herself felt the effect of the disturbances. From the "isles in the midst of the Great Green Sea," there no longer came the peaceful Minoans to pay their friendly tribute to Egypt's King; instead there came the unpeaceful Achæans, on an unpeaceful mission. Two raids were made—if we may trust the students of Egyptian records[2]—one about 1230 B.C., another about 1200 B.C. Not long after we find the Achæans, in Agamemnon's famous expedition, fighting against the Trojans in Asia Minor; and they took the city at last in 1184 B.C., if we accept the date supported by the weight of Greek tradition. It is their deeds in the latter war that have been sung by Homer. Two generations after the Trojan War, shortly before 1100 B.C., Greece was overrun by the Dorians, who formed the second great wave of Northern invaders. After that came the Dark Age, out of which about 800 B.C. emerged classical Greece.

Classical Greece was the fusion of the two main elements of prehistoric times, the artistic Mediterranean people on the one hand, and the robust Northern invaders on the other. Just as the fusion was probably consummated in the Dark Age, so the first poet of classical Greece, Homer, whether one person or the embodiment of many, heralded their new life in song which seemed to echo from that Dark Age, but of which the substance was probably far less legendary than historical. Whether the traditions of the Minoan Age in Crete were kept alive through the Dark Age in Ionia, whither it is thought that they were carried by Achæan refugees at the time of the Dorian invasion, which extended to Crete, or whether they remained dormant in Crete itself, and in the Mycenæan centres of the mainland of Greece, it is in either case certain that they were abundantly preserved, for their traces are plainly to be seen throughout Greek civilisation. And from the Greek writers they descended as a treasured heritage to the poets of Rome, and so to the art and literature of Europe.

The Structure of the Universe

By the Rev. Hector Macpherson, M.A., F.R.A.S., F.R.S.E.

(*Continued from January No., p.* 8)

II. Twenty Years of Progress

So far as astronomical science is concerned, the twentieth century bids fair to be the "wonderful century." In no other period of equal length as the two decades since 1900 has the rate of progress been so rapid. All branches have gone forward, in greater or less degree; but in none of the sub-sciences into which astronomy is now divided has so much been accomplished as in the department relating to the structure of the stellar universe. There have been various reasons for this rapid advance. The present generation has come into a great heritage—the accumulated observational treasures of the past two centuries, which Dr. Abbot has called "that precious store of exact knowledge whose value time cannot impair, but can only enhance." The observations of Bradley, for instance, become more precious with the passage of the years; so do the tabulated surveys of the Herschels, of Bessel, and of Argelander and Schönfeld, the photographic surveys of Gill, and the pioneer spectroscopic work of Secchi, Vogel, and Pickering. The nineteenth-century astronomers were largely occupied in amassing observations; in the twentieth, we are, in some measure at least, reaping the fruits of their labours. A second factor in the remarkable progress of this branch of astronomy is the rapid development of the powers of the telescope—and consequently of the spectroscope—during the last thirty years. The great refractors of the Lick, Lowell, and Yerkes Observatories in the United States have been employed—the two former in superb climates—with the highest advantage to stellar astronomy. More recently the great reflectors of Mount Wilson have carried us still further into the depths of space.

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[1] Herodotus, i. 73.

[2] See H. R. Hall, *The Ancient History of the Near East* p. 70 (Methuen, 1913). Mr. Hall gives the more definite date of *c.* 1196 for the second invasion.

As remarked in the previous article, astronomers in the nineteenth century were obliged to concentrate on the study of stellar distribution; comparatively few stellar distances and motions had been determined with accuracy. By the opening years of the century, however, it was evident that the investigation of stellar motion was to prove a valuable line of attack on the ultimate problem. In 1904 Professor Kapteyn, of Groningen, read at the Astronomical Congress at St. Louis, U.S.A., a paper of far-reaching importance, in which he announced the discovery of star-streaming. As is well known, there are two components in the motion of each star: (1) the parallactic motion due to the movement of the sun, carrying with it the earth and the other planets, and (2) the individual proper motion. Formerly it was believed that after the parallactic motions were eliminated the individual motions were more or less at random. This assumption Kapteyn showed to be erroneous. After eliminating the parallactic motion from the motions of the bright stars in the catalogue of Bradley, revised by Auwers, Kapteyn found that the motions of the stars fell into two opposite directions in the galactic plane. This result he interpreted as indicating that the brighter and nearer stars belong to one or other of two vast interpenetrating star-streams.

Shortly afterwards these results were abundantly confirmed by the independent work of Professor A. S. Eddington, then chief assistant at Greenwich, now director of the Observatory at Cambridge. In his first paper on "The Systematic Motion of the Stars," read before the Royal Astronomical Society in November 1906, Eddington made what he called "the attempt to subject Kapteyn's theory to a quantitative test by examining the Greenwich-Groombridge proper motions. The following reasons, among others, seemed to make this desirable. The Bradley stars are all bright stars; of those of the Groombridge catalogue a large number fall between the seventh and ninth magnitudes. The 2,500 stars of Bradley's catalogue cover most of the sky; the 4,500 stars of Groombridge are all within 52° of the north pole." The result of the investigation was a complete confirmation of Kapteyn's theory. Eddington ascertained that the velocity of the first drift of stars relative to the sun was very much greater than that of the second, and that there was no appreciable difference in the main distances of stars of the two drifts.

A further stage was reached by the paper which Sir F. W. Dyson—then Astronomer-Royal for Scotland—read before the Royal Society of Edinburgh in 1908. His investigation covered 157 stars within 52° of the north pole, taken from Groombridge's catalogue; 165 stars within 50° of the South Pole from the Cape Astrographic Catalogue, from Porter's Cincinnati Catalogue, and the Cape General Catalogue; and 778 stars within a belt extending 30° north and south of the equator, from the Cincinnati Catalogue. The results of this study of stars, scattered all over the sky, were strongly in support of the two-drift hypothesis. "The quick-moving stars here considered show the streams in a very pronounced light." Confirmation of the two-stream theory was also forthcoming from Professor Campbell's investigation of radial motion. Dr. Halm, of the Cape Observatory, not only confirmed the hypothesis by his own researches, but came to the conclusion that there were not only two drifts, but three.

Various hypotheses were put forward to explain the existence of the two star-streams. Local streams had, of course, been known since Proctor pointed out the community of proper motion of five of the stars of the Plough; but the work of Kapteyn, Eddington, and Dyson indicated that the great mass of the brighter stars belonged to two or three streams, and this called for a theoretical explanation. The problem before the theoretical astronomer was to preserve the unity of the universe. In 1908 Schwarzschild, of Potsdam, put forward his ellipsoidal hypothesis, and in 1912 Turner, of Oxford, outlined a new theory reconciling the observed duality of the universe with the unity which theory seems to demand. In 1911 Eddington remarked, however, that "the two star-streams probably involve at least half a million of the stars around us; but there has never been any evidence that they prevail in the extremely remote parts." This has been confirmed in recent years, and the two-drift phenomenon finds its explanation in the comprehensive cosmological scheme of Dr. Harlow Shapley.

Since the opening of the century, various new methods of determining the distances of stars have been devised; and in this way it is now possible to speak with some degree of confidence of the scale on which the universe is built. In the first place, Kapteyn, as early as 1901, indicated the possibility of ascertaining the mean parallaxes of groups of stars. Secondly, Dr. W. S. Adams, at Mount Wilson, found some years ago that the intensities of certain lines in stellar spectra depend on the absolute luminosity of the stars, and as a result he has been enabled to measure the distances of hundreds of stars by the spectroscope, and thus to add enormously to our knowledge of exact stellar distances. Thirdly, Professor H. N. Russell, of Princeton, from his study of "eclipsing-variable" stars, was able to ascertain the absolute

THE STAR-CLOUDS OF THE GALAXY IN THE DIRECTION OF SERPENS AND SAGITTARIUS

From a photograph by Professor Max Wolf.

magnitude, and thus to compute the parallaxes of nearly a hundred of these. Fourthly, in the large class of variables known as Cepheids, the length of the period of variation has been ascertained to depend on the absolute brightness. The mean parallaxes of the nearer of these variables being known, it is possible to determine the absolute magnitude, and thus the distance of every Cepheid variable in the heavens. Finally, Russell and others have indicated theoretically a method of ascertaining the minimum distance of the bright helium stars of type B. Only stars of very large mass are able to attain to the unusually high temperature of B-type stars; hence a B-star, however faint it may appear, must have a certain minimum absolute magnitude. All these new methods of determining and estimating distance have contributed to a great extension of our knowledge of the extent and structure of the universe. Further, in recent years it has become possible to ascertain the hypothetical spectral type of the very faint stars. As is well known, the photographic plate is more sensitive than the eye to certain wave-lengths of light; the difference between the photographic and the visual magnitude of a star is therefore due to the colour of the star, and is called the colour-index. Thus it is possible to determine the colour, and hence the approximate spectral type, of very faint stars whose spectra cannot be directly observed.

As a result of these new methods of investigation several researches of the utmost importance have been undertaken within the last few years. In 1916 Professor Charlier, of Lund, published a paper on "The Galaxy of the B-type Stars," in which he started from the assumption that the B-stars do not differ much in absolute magnitude. Having made this assumption, he was enabled to determine the distances of stars of this type brighter than the fifth magnitude. He found that these stars form a well-defined flattened cluster—whose plane is very similar to that of the Galaxy—with its centre of gravity in the constellation Carina. The farthest limits of the cluster Charlier found to be at a distance of 750 parsecs[1]—roughly corresponding to about 2,000 light-years. "We are," said Charlier, "in a position to get, with the help of the B-stars, what might appropriately be called a skeleton image of the Milky Way." In other words, Charlier assumed that the system of B-stars was co-extensive with the stellar universe.

In 1913 Professor Hertzsprung, of Potsdam, from a study of the Cepheid variable stars in the Lesser Magellanic Cloud, estimated the absolute magnitudes of these stars, and thus their distances and the distance of the cluster. The distance at which he arrived was 10,000 parsecs—corresponding to about 30,000 light-years. In the following year Dr. Harlow Shapley, the brilliant American astronomer, commenced, with the aid of the great 60-inch reflector of the Mount Wilson Observatory, his studies on the colours and magnitudes in stellar clusters. The clusters investigated were of two classes, the compact globular clusters and the open galactic clusters which are undoubtedly condensations of distant Milky Way stars. The results reached by Dr. Shapley during the first two years of his investigation were sufficiently startling. In the galactic star-clouds in the vicinity of the open cluster Messier 11, he discovered faint blue stars obviously of type B. "The cluster-stars," wrote he in April 1917, "are probably giants in luminosity, and accordingly the distance of the group must be of the order of 15,000 light-years. The wide dispersion in magnitude of both blue and red stars indicates a similarly great distance for the neighbouring galactic clouds. It suggests that the extent of the stellar clouds in the line of sight is relatively very great—in fact, the depth may be as great as, or greater than, the distance to the nearer boundary."

No less remarkable were Shapley's preliminary conclusions regarding the brighter globular clusters. The first of these exhaustively studied was the great cluster in Hercules (Messier 13). In his paper on this cluster, dated August 1915, Shapley estimates its distance from "considerations of its variable-stars, its fragmentary luminosity-curves, and the average apparent brightness of certain colour groups," as 100,000 light years, a distance much greater than had ever been imagined for the cluster.[2]

Dr. Shapley's subsequent researches have been given to the world in the series of "Contributions from the Mount Wilson Observatory," and have been admirably summarised in his recent pamphlet on "Star-Clusters and the Structure of the Universe." By means of the various methods of determining absolute magnitude and distance, Shapley has fixed the positions in space of eighty-six globular clusters. He finds these to be "cosmic units," sub-systems dependent on the greater galactic system, at enormous distances from our earth. The nearest, Omega Centauri, is 20,000 light years away, and the most distant—known as N.G.C. 7006—is so distant that light requires 220,000 years to travel from the cluster to the earth. Shapley finds the clusters arranged in a certain symmetrical way, which indicates that they are dependents of the sidereal system—as Professor Perrine suggested in 1917—and that the sun is not near the centre of the universe, as was generally

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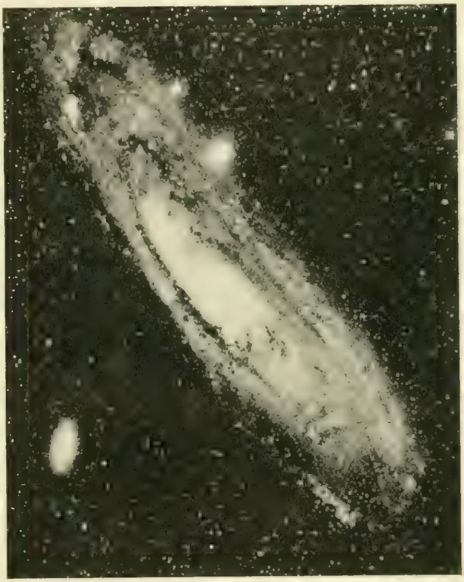
[1] The parsec is the distance which corresponds to a parallax of one second of arc. It is equal to nineteen billions of miles.

[2] A later measure by Dr. Shapley gives a distance of 36,000 light-years.

believed. Shapley's researches indicate that the centre of gravity of the sidereal system is in the constellation Sagittarius, amid the dense star-clouds of that region, 60,000 light-years from the sun. The stellar system itself is seen to be much vaster than has been hitherto believed. "The study of the distances and structure of globular clusters has shown that in volume the galactic system is more than a hundred thousand times as large as we formerly believed it to be"—at least 300,000 light-years in diameter. "The phenomenon of the Milky Way is largely an optical one. Although the existence of local and occasionally very extensive condensations of Milky Way stars is not denied, the conception of a narrow encircling ring is abandoned. The Milky Way girdle is chiefly a matter of star-depth, and its long-recognised weakness between longitudes 90° and 180° is now taken to be a reflection of the eccentric portion of the sun." The system is vastly more extended in the galactic plane than in the direction of the poles. "A thin central stratum of the galactic segment contains every star that has been seen or has been photographed for our catalogues. This stratum of stars apparently deviates less than two thousand light-years from the galactic plane." In other words, Shapley's researches show the sidereal system to be a flattened disc, about 4,000 light-years in thickness and 300,000 in diameter. We have reverted, therefore, in great measure to Herschel's standpoint and to Herschel's conception of the vastness of interstellar space. Grouped round about the sidereal system are the subordinate clusters which Shapley believes to be gradually falling into the larger system, which is, in fact, an assemblage of absorbed clusters. He considers the stars in the vicinity of the sun—including Charlier's galaxy of B-type stars which that astronomer thought to be co-extensive with the universe—to form a local cluster—a striking confirmation of the theory put forward years ago by B. A. Gould. The interpenetration of this cluster with the general galactic stars gives rise to star-streaming, which is, as Eddington maintained ten years ago, a local phenomenon confined to the stars in the vicinity of the sun.

Such, then, is the vast universe which Dr. Shapley's researches have revealed to man—a universe so vast that the mind is staggered by its contemplation. Is it the only universe? During the past decade the fascinating theory of "island universes" has been revived in a new and plausible form. In November 1911 Professor F. W. Very put forward the view that the faint white nebulæ were not actually gaseous, but distant stellar systems—island universes, of which the smallest and faintest was a million light-years away. In 1912 Dr. V. M. Slipher commenced, at the Lowell Observatory, his measures of the radial velocities of the spiral nebulæ. Grave doubts had already been thrown by spectroscopic evidence on the supposed gaseous nature of these nebulæ—the spectrum of the typical spiral being continuous. Slipher's investigations indicated that "the average velocity of the spirals is about twenty-five times the average stellar velocity." This differentiates them from the ordinary nebulæ; so does the peculiarity of their distribution. Unlike the planetary and irregular nebulæ, they avoid the galactic regions, and are most numerous near the galactic poles. These facts seemed to emphasise the non-nebular, extra-galactic nature of the spirals, and accordingly many of the most eminent astronomers—such as Eddington and others—have been disposed to look favourably on the "island universe" hypothesis. The Messrs. Lindemann, in their recent preliminary application of photo-electric photometry to astronomy, have reached an estimate of the distance of the Andromeda nebula, the greatest of the spirals. They find it to be distant 350,000 parsecs, or a little over 1,000,000 light-years, maintaining that there is "nothing inconsistent in regarding this nebula as a galaxy very similar to our own."



THE GREAT SPIRAL NEBULA IN ANDROMEDA.
(From a photograph by Ritchey, of the Yerkes Observatory.)

The recent work of Shapley, however, would seem to indicate that, whatever the spirals are, they are not of equal status with the galactic system. He regards there is one of two types of organisation in extra-galactic space—the evidence suggesting that the "galactic system now moves as a whole through space, driving the spiral nebulæ before it." Repulsion, not gravitation, appears to be the ruling power so far as the spirals are concerned. "Is it possible," asks Shapley, "that the spirals represent the failure to form stars from the original condensing nebulosity through the presence of too much material?" The spirals, he suggests, may be composed of "particles of molecular dimensions peculiarly susceptible to the pressure of such radiation as is emitted by the stars." If this be so, the spirals may be said to represent the waste material of the universe, and to be in a sense analogous to the cometary and meteoric matter within the solar system.

Whatever be the status of the spirals—whether or not they indicate the existence of many systems coequal with the vast sidereal organisation in which our sun is but a dwarf star—there can be no doubt that the recent progress of astronomy has enormously widened our mental horizon, having revealed a sidereal system so vast that we are powerless to grasp its immensity—a sidereal system which dwarfs to utter insignificance the tiny globe on which we live and the tiny star round which that globe revolves. "Such," to quote the words of Flammarion forty years ago, but more applicable to-day than when they were written, "is the aspect, grand, splendid, and sublime, of the universe which flies through space before the dazzled and stupefied gaze of the terrestrial astronomer, born to-day to die to-morrow on a globule lost in the infinite night."

BOOKS FOR FURTHER READING

Collected Scientific Papers, by Sir William Herschel.
History of Physical Astronomy, by Robert Grant.
The Universe of Suns, by R. A. Proctor.
The Visible Universe and the *Concise Knowledge of Astronomy*, by J. E. Gore.
The Stars, by S. Newcomb.
Stellar Motions, by W. W. Campbell.
Stellar Movements and the Structure of the Universe, by A. S. Eddington
Studies based on the Colours and Magnitudes in Stellar Clusters, in "Contributions from Mount Wilson Observatory," by Harlow Shapley.

The Elder Edda and Ancient Scandinavian Drama. By BERTH S. PHILLPOTTS, Litt.D. (Cambridge University Press, 21s.)

The Groundwork of Modern Geography. By ALBERT WILMORE, D.Sc. (G. Bell & Sons, 6s.)

A Dictionary of Scientific Terms. By I. F. and W. D. HENDERSON. (Oliver & Boyd, 18s.)

"The Winter's Tale" and its Source

By Robert Dewar, M.A.

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THE earliest proofs of Shakespeare's popularity as a dramatist date from 1592. And the most convincing, though not the first or the sweetest, was Greene's ill-natured death-bed warning of that year to his fellow-playwrights. "There is," wrote Greene in *A Groatsworth of Wit bought with a Million of Repentance*, "an upstart Crow, beautified with our feathers, that with his Tyger's heart wrapped in a player's hide supposes he is as well able to bumbast out a blanke verse as the best of you; and being an absolute Johannes Factotum is, in his owne conceit, the only Shake-scene in a countrie." Greene's was not a generous nature: applause was meat and drink to him; and he loathed the very suspicion of a rival. Least of all could he bear to be put down by a Shakespeare—by a man who had never known a University, a mere player who dared to emulate his betters. But it is doubtful if others shared Greene's envy. Before the year was out, Greene's publisher tendered an apology, in which he confessed the young Shakespeare's "demeanour no lesse civill than he excelent in the qualitie he professes," and praised "his uprightnes of dealing, which argues his honesty, and his facetious grace in writing that aprooves his art."

How Shakespeare himself regarded the incident we cannot know for certain. There is nothing to show that he hated Greene in return. Yet some have thought that Shakespeare felt the attack keenly and never forgave it, though Greene had died almost as soon as his libel was uttered. Shakespeare took his revenge, they say, in *The Winter's Tale*—a play written in 1611, some nineteen years later, and probably the last which he made alone. It is a strange coincidence, no doubt, that in the evening of life when he thought to retire from the theatre and all its business, Shakespeare should choose a story of Greene's to supply him with the matter for a last play. But need we infer that there was any spiteful motive in the choice merely from the fact that Shakespeare's version surpasses Greene's? Other tales by other writers had been borrowed in the same way and been so far improved that the original was quite forgotten. And, after all, Shakespeare has not destroyed Greene's story utterly: one or two passages, and those the best, he has spared untouched. Their preservation may suggest a better motive than malignity on Shakespeare's part. The manner of their preservation offers a pleasant field in which to study his methods of composition.

Greene's story was called *Pandosto, the Triumph of Time*, and was published in 1588. In the next century it was renamed by the booksellers, less appropriately, as *The Pleasant History of Dorastus and Fawnia.* It may be summarised as follows: Egistus, King of Sicily, visits Pandosto, King of Bohemia (a sea-coast country as in Shakespeare's play). Pandosto grows suddenly jealous of his guest and of his own queen Bellaria. Egistus, with the aid of the cup-bearer Franion, escapes. But Bellaria, accused by her husband and brought to trial, learns, as a climax to her griefs, of the death of her only son Garinter, and dies in court. Meanwhile, her new-born daughter Fawnia, set adrift upon the sea, has been carried by the waves to Sicily, where she is found and nurtured by an old shepherd and his wife. Prince Dorastus of Sicily, Egistus' son and heir, is presented to us as a contemner of love. Revolting against his father's proposal to marry him to a Danish princess, one day, as he returns from hawking, he sees Fawnia; falls in love with her at once; and, before his father can learn of the attachment, escapes with her on board ship—carrying along with him the old shepherd, to prevent discovery. The ship is driven by storms into Bohemia, and the lovers in disguise reach Pandosto's court, where Pandosto falls grossly in love with his own daughter. When at last Egistus tracks his son's whereabouts, and the truth is made plain to all concerned, Pandosto kills himself in despair for his sins.

If now we compare this with the events of Shakespeare's play, it would appear that the divergence from Greene is not remarkable till we reach the second part of the story, concerning the loves of the princes. In other words, the opening scene of the fourth act of *The Winter's Tale*—the speech of Time as Chorus, announcing the silent passage of sixteen years—not only marks a break in the plot, but divides the play conveniently for our purpose of comparing it with its source. The two parts separated by this scene have been differently rebuilt.

Let us confine ourselves for the moment to the first part. The impression conveyed by these three acts to anyone who knew the novel well and was reading the play for the first time, would naturally be that Shakespeare was simply translating a piece of narrative into dramatic form. The interest of the story may be more keenly felt; the characters may be presented more vividly and with surer touch, as well as under new names—that was to be expected. But throughout this part there is nothing to warrant the expectation of a *dénouement* other than that of the novel. The story of Leontes' jealousy of his queen, Hermione, and his friend, Polixenes; of the friend's escape and the queen's imprisonment; of Perdita's birth in prison and her abandonment to the mercies of the sea; of her mother's trial and acquittal, thanks to an answer given by the Oracle of Apollo; of the death of Leontes' sole heir, Mamillius; and of Leontes' grief and repentance—all this is retold from the corresponding part of Greene's novel. Incidents of the original which are not actually reproduced, we shall find, none the less, preserved by being mentioned in this or that speech; if some new character is added, we shall find that the requirements of a drama sufficiently explain the change. Thus the trial scene of Hermione (III, 2) does duty for the two appearances in court of her prototype Bellaria; and so Shakespeare makes Leontes send to consult the Oracle on his own initiative, not (like Pandosto) at the request of his queen on her first appearance before her judges. Drama often needs thus to compress a story which there is room in a narrative to expand. Again, in the first scene of all, Archidamus—Shakespeare's own creation—is introduced merely to gather up in dialogue with Camillo, the opening passages of the novel, to define the starting-point of the play. And so of all the slight divergences from the plot of the novel in these first three acts, we may say with truth that they are due to the requirements of drama, save perhaps in two instances—the additions, namely, of the characters of Antigonus and of his wife Paulina.

GREENE IN HIS SHROUD COMPOSING.

From "The English Novel in the Time of Shakespeare," by J. J. Jusserand.

Paulina's function in the play is really to bring about a conclusion quite different from that of the novel; at her home, Hermione will be hidden to await the final reconciliations. But this is about the last thing we learn in Shakespeare's management of the story—the first hint of such a purpose being given only in the fifth act. To one who has read no further than the close of the first part of the play, she is simply a woman whose tongue (as she expresses it) is " trumpet " to her " red-look'd anger." Shakespeare, that is, had to give in speech what Greene renders by a plain statement—that the nobles and court generally were troubled to see their king so unreasonably jealous ; and that their protests helped at least to dissuade him from his first intention of burning to death both his queen and the daughter she had borne in prison. Hence Shakespeare invents this woman with a tongue and her respectful husband. The reason for creating both—so far as one might gather from the first three acts—was simply that the opposition of the court to the frenzy of Leontes might be effectively voiced. They are born, so to speak, of the essential difference between drama and narrative.

This explanation of the appearance of Paulina, as we have seen, is really incomplete, if we are dealing with more than the first acts of the play. No such qualification is called for in Antigonus' case. Yet Antigonus gives rise to the first remarkable alteration of Greene's plot by Shakespeare ; and until we come to the second part it is the only one that could possibly rouse even a suspicion of any other motive than the dramatisation of the plot. I refer to the last scene of the first part, the abandonment of Perdita on the coast of Bohemia.

For clearness' sake Greene's account of the rescue must be quoted at length. Fawnia (Perdita) was set adrift by her jealous father, Pandosto (Leontes), in " a little cock-boat." Tempest-tossed for " two whole days . . . at last . . . the little boat was driven with the tide into the coast of Sicilia " [Shakespeare reverses the scenes] " where sticking upon the sands it rested." The narrative then continues as follows[1]:

" It fortuned that a poor mercenary shepherd that dwelled in Sicilia, who got his living by other men's flocks, missed one of his sheep ; and, thinking it had strayed into the covert that was hard by, sought very diligently to find that which he could not see ; and fearing either that the wolves or eagles had undone him (for he was so poor that a sheep was half his substance), wandered down to the sea cliffs to see if perchance the sheep was browsing on the sea ivy, whereon they greatly do feed ; but not finding her there, as he was ready to return to his flock he heard a child cry ; but knowing there was no house near, he thought he had mistaken the sound and that it was the bleating of his sheep. Wherefore, looking more narrowly, as he cast his eye to the sea he spied a little boat, from whence, as he attentively listened, he might hear the cry to come. Standing a good while in a maze, at last he went to the shore, and wading to the boat, as he looked in he saw the little babe lying all alone ready to die for hunger and cold, wrapped in a mantle of scarlet richly embroidered with gold, and having a chain about the neck.

" The shepherd, who before had never seen so fair a babe nor so rich jewels, thought assuredly that it was some little god, and began with great devotion to knock on his breast. The babe . . . began again to cry afresh, whereby the poor man knew that it was a child, which, by some sinister means, was driven thither by distress of weather ; marvelling how such a silly [i.e. innocent] infant, which by the mantle and the chain could not be but born of noble parentage, should be so hardly crossed with deadly mishap. The poor shepherd, perplexed thus with divers thoughts, took pity of the child, and determined with himself to carry it to the king, that there it might be brought up according to the worthiness of birth, for his ability could not afford to foster it, though his good mind was willing to further it. Taking therefore the child in his arms, as he folded the mantle together the better to defend it from cold, there fell down at his foot a very fair and rich purse, wherein he found a great sum of gold ; which sight so revived the shepherd's spirits that he was greatly ravished with joy and daunted with fear ; joyful to see such a sum in his power, and fearful, if it should be known, that it might breed his further danger. Necessity wished him at least to retain the gold, though he should not keep the child : the simplicity of his conscience feared him from such deceitful bribery. Thus was the poor man perplexed with a doubtful dilemma, until at last the covetousness of the coin overcame him ; for what will not the greedy desire of gold cause a man to do ? So that he was resolved in himself to foster the child, and with the sum to relieve his want. Resting thus resolute in this point he left seeking of his sheep, and, as covertly and secretly as he could, went by a by-way to his house, lest any of his neighbours should perceive his carriage. As soon as he was got home, entering in at the door, the child began to cry, which his wife hearing, and seeing her husband with a young babe in his arms, began to be somewhat jealous, yet marvelling that her husband should be so wanton abroad sith he was so quiet at home ; but as women are naturally given to believe the worst, so his wife, thinking it was some bastard, began to crow against her goodman, and taking up a cudgel (for the most master went breechless) swore solemnly that she would make clubs trumps if he brought any bastard brat within her doors. The goodman, seeing his wife in her majesty with her mace in her hand, thought it was time to bow for fear of blows; and desired her to be quiet, for there was none such matter; but if she could hold her peace they were made for ever: and with that he told her the whole matter, how he had found the child in a little boat, without any succour, wrapped in that costly mantle, and having that rich chain about the neck. But at last, when he showed her the purse full of gold, she began to simper something sweetly, and, taking her husband about the neck, kissed him after her homely fashion, saying that she hoped God had seen their want and now meant to relieve their poverty, and, seeing they could get no children, had sent them this little babe to be their heir. 'Take heed, in any case,' quoth the shepherd, 'that you be secret, and blab it not when you meet with your gossips, for, if you do, we are like not only to lose the gold and jewels, but our other goods and lives.' 'Tush,' quoth his wife, 'profit is a good hatch before the door: fear not, I have other things to talk of than this; but I pray you let us lay up the money surely and the jewels, lest by any mishap it be spied.' "

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[1] Save that for convenience it has been here and there modernised.

The sequel brings play and novel into something like their old resemblance. Porrus and Mopsa (the old shepherd and his wife) prospered greatly; Fawnia, as they named their foster-daughter, grew in beauty as in years, "a jolly girl," and the cause latterly that Porrus' house was frequented by "divers rich farmers' sons"; till at last Dorastus (Florizel) and she meet and begin their adventures.

But to deal with the passage quoted, and with its substitute in the play. The great difference in treatment at this point between Greene and Shakespeare is due ultimately to the demands of the medium which the latter was employing. But the immediate explanation of Shakespeare's failure (shall we say?) to make as full use of the novel here as he did in earlier passages, is mainly the fact that he has saddled himself with Antigonus. Having been created to oppose Leontes and so earn his hatred, it was an almost natural consequence that he should be sent to bear the supposed "bastard" away, as Leontes decrees,

> "To some remote and desert place, quite out
> Of our dominions; and that there thou leave it,
> Without more mercy, to its own protection
> And favour of the climate."

Hence in the play we have the voyage, the landing in Bohemia, the sudden storm, the clamour of the chase, and the direction "Exit (Antigonus) pursued by a bear." The lonely deserted quiet of the novel, so beautifully appropriate, is sacrificed; and with it much else. The shepherd enters muttering his wrath against "these boiled brains of nineteen and two-and-twenty," who disturb his sheep with their hunting; and discovers the foundling. But there is no superstitious knocking on his breast; nor is there any soliloquy, to correspond with the narrative of Porrus' "doubtful dilemma," or anything of the secret "by-way" journey home, and the humorously realistic reception of the shepherd by his wife. Shakespeare is under the necessity of ensuring that no word of the child's fate shall reach the father yet. Instead, therefore, the shepherd halloos to his son—Shakespeare provides him with one—and the comedy of the scene is shifted from the old man and the foundling to the clownish rehearsal by this son of the sights he had just witnessed, namely, a whole ship's crew wrecked in the storm, and the bear that has already "half-dined on the gentleman" and "'s at it now"; (the destruction, that is, of all such evidence as might prevent the play's running to the normal five acts). That Greene's version by itself might be dramatised without appreciable loss, seems not impossible. There are two scenes—the sea-coast and the shepherd's house—and the pathway connecting them. But these might be combined, and nothing let slip, by opening before the house: for the humour of Porrus' dilemma lies entirely in the situation, depending really upon his being only half-conscious of the thoughts we can perceive passing through his brain; so that dumb-show, the gesture and behaviour of the actor while approaching the house, could do for us, much more effectively than any speech, what Greene is really doing with the aid of a freer, narrative medium, namely, interpret in a lively way what is implied in the situation. But of course, since it was necessary that Antigonus and the ship's comany must be destroyed—and destroyed, with a view to later developments, before some witness—the scene must be at the coast instead of at the shepherd's house; and so the readiest method of using the novel at this point becomes impossible. While, then, the dramatic medium called for some departure from the novel here as elsewhere, the much wider departure than usual and the particular form which that departure takes, are due to the other changes already made for similar reasons. And surely the result of leaving to Greene's credit one of his happiest inventions, unsullied and safe from the dangers of comparison, cannot possibly be called "vindictive." If Shakespeare remembered the quarrel of 1592 with bitterness, would he have worked so as to efface only the worst parts of his enemy's book?

I have said that the scene we have discussed might rouse a suspicion, in one acquainted only with the novel, of more than mere dramatisation. It is just perceptible to a careful reader that the old shepherd is rather more subordinated in the play than in the novel to the main characters and plot. Perdita arrives in her new country with more ceremony. The presence of Antigonus and a ship, even the noise and hollooing of the chase—those " boiled-brains " of the huntsmen who explain the shepherd's entrance and his grumblings—these things keep Perdita as the real centre of interest, and take away from the prominence of the shepherd, placing him and the world he represents rather in the background of the picture. Beyond this, however, there is no hint given of what may follow ; and any suspicion awakened here will certainly have no confirmation till we cross over to the second part of the play.

But from the very first scene, almost from the first word of that second part, which we must now consider, we do begin to imagine another end in view. For while the novel still remains the basis of the play, the divergence throughout this part is so complete that no single scene can fairly be described as a mere dramatisation of the original narrative. And the explanation is that here at last Shakespeare is working, definitely and obviously, to eliminate the tragic and unpleasant portions of the novel, with a view to a *dénouement* of reconciliation all round. In Greene's story Bellaria drops dead in court on hearing of the death of her son Garinter. Shakespeare, keeping the matter secret till the end, puts Bellaria's successor, Hermione, into hiding only, that he may give her back to the repentant Leontes in a final tableau. The widowed Paulina must also be rewarded ; so Camillo at the very opening of this second part, unlike his prototype Franion in the novel, is discovered to be still, and very much, in the business of the story. These intentions necessarily affect the structure of the play ; and they explain the much freer use of Greene henceforward.

Note first Shakespeare's principal omissions. In the novel, Prince Dorastus, disguised as a shepherd, comes a-wooing of Fawnia, the supposed daughter of old Porrus. Before their elopement, and indeed to furnish something of a motive for elopement, Greene tells of the negotiations begun by the prince's father, Egistus, for the marriage of his son to a Danish princess. All this is not so much as referred to in the play. It was likely to be dropped by anyone dramatising Greene's story ; for it is after all only an episode in the plot. But an allusion might have been made to it with ease had Shakespeare so wished. That he did not so wish is probably due to the tone of the episode in Greene. For Greene uses this part of Dorastus' history to show him as the cynical despiser of love and sentiment, on the eve of his first vision of Fawnia. Shakespeare's lovers, his Florizel and Perdita, were conceived too ideally to need any such conventional contrast to impress us with the depth and beauty of their love. A " cynical " past for either is unbelievable ; it would jar upon our sense of the fitness of things. And with the suppression of this episode, Shakespeare avoided also presenting Perdita, like Fawnia, as once upon a time fickle in her love, but persuading herself to constancy as " hoping in time to be advanced from the daughter of a poor farmer to be the wife of a rich king."

Another omission worth noting must have been less easy. In the novel the lovers—together with Porrus, who is kidnapped and taken on board the ship—propose to escape to Italy ; but being storm-driven upon Pandosto's country, they conceal their names and intentions, giving out that they are Trapolonians on their way from Padua to Trapolonia. Pandosto, however, suspects that Dorastus has stolen Fawnia from her parents. He imprisons Dorastus ; and then becoming himself enamoured of Fawnia, attempts to win her love, not knowing of course that she is really his long-lost daughter. This ugly situation is relieved only when, after much delay, the whereabouts of the lovers is revealed by chance to Dorastus's father, and emissaries reach Pandosto from Egistus to explain these " Trapolonians." Here again the happy ending which Shakespeare designed forbade inclusion of an incident so unpleasant ; to have told or even suggested it would have poisoned the sweet air of *The Winter's Tale.* But how to omit it ? The only way was to shorten the period between the flight of the lovers and their pursuit. And indeed Shakespeare's choice of this method for this purpose is foreshadowed at the very beginning of his second part. We look for a short cut to the conclusion, instead of Greene's more leisurely approaches, when we note that Polixenes, unlike Egistus, knows how his son frequents the shepherd's cottage ; and in order to spy upon his conduct, proposes to go disguised there with Camillo.

But this speeding of the action to eliminate the unpleasant is best seen by comparing in some detail the methods employed by Greene and Shakespeare respectively to get the lovers clear of the country. In Greene it is the shepherd Porrus who first learns the truth about the love-making and is troubled. He decides to warn the king, and clear himself by revealing all he knew of Fawnia's identity. So one morning, having heard that " the king would go abroad to take the air, (he) called to his wife to bring him his holiday hose and his best jacket, that he might go, like an honest substantial man, to tell his tale. His wife, a good cleanly wench, brought him all things fit, and sponged him up very handsomely, giving him the chains and jewels in a little box, which Porrus, for the more safety, put in his bosom. Having thus all his trinkets in a readiness, taking his staff in his hand he bade his wife kiss him for good luck, and so he went toward the palace." Now this very morning Dorastus had laid his plans to sail away with Fawnia; and he had taken one Capnio into his confidence to help him. Porrus meets Capnio, who suspects his intention from his tidy appearance, and so decoys him successfully on board the ship. Thus in the novel are Fawnia, her lover, and the necessary evidence of her high birth got conveniently together, to be storm-driven unawares (as already said) upon her father's kingdom. In Shakespeare, on the other hand, the king Polixenes, by learning of the love-making and surprising the culprits at the sheep-shearing, compels the prince to plan escape on the spur of the moment. There is no time to find or consult a confidant. Shakespeare therefore drops the Capnio of the novel, dividing his functions—first of aiding the flight, and second of trapping the old shepherd—between Camillo and Autolycus. The latter, Shakespeare's own and greatest addition to the characters of the play, created without the shadow of a hint from Greene, performs his part with the shepherd, delighting us at the same time with some of his best sallies. Camillo, meanwhile, the king's accomplice in the spying, having served his own desire to get home again to Sicily by forwarding, and even instigating, an escape thither, is on his way after the king to court; where he will duly relate the action of his young friends, and contrive to join the company sent after them. Shakespeare, that is, by having his own instruments ready for a more rapid accomplishment of this part of the story, secures also that the pursuit shall not wait till some one of the search-party, organised to find the missing prince, should chance to meet with "a fisherman that was mending his nets, when Dorastus and Fawnia (Florizel and Perdita) took shipping." The two consequently reach Leontes' court just before the arrival of messengers from Polixenes and of Polixenes himself; and Leontes, though attracted by the beauty of Perdita, as recalling his lost Hermione, is in no danger of displaying such grossness as Pandosto.

But Shakespeare did more than omit and suppress. His purpose of achieving a completely happy issue appears even more clearly in what he added to the story as told by Greene.

Autolycus the pedlar is the greatest, perhaps also the most significant of all the additions. As we have seen he was needed to supply in part the omission of the confidant Capnio. But this is only part, and a small part, of the function assigned to him by Shakespeare. Note that his entrance is earlier than is strictly necessary for this service alone. The story has advanced no further than the mere announcement of a shepherds' gathering, through the revelation of Polixenes' design to attend it in disguise, when, before the shepherds actually assemble, we first meet Autolycus on his way there also. He enters singing; and his songs are the life and soul of this little scene —a prelude to the revels and merry-making of the shepherd-feast that succeeds. The true function of Autolycus is to pitch the lyric note of the coming love-scenes, and generally to herald by his songs and his cheerfulness the dawn of happier days, of a cloudless summer for those we love and for all their friends.

Of Shakespeare's elaborations the most striking is the sheep-shearing revel. Built upon a casual phrase in Greene, this scene with the lovers' escape that grows from it, occupies no less than half of the whole second part of the play. Here again the change is made to create the right atmosphere for the new ending of all-round reconciliation. Moreover, the essence and effect of the divergence reveals plainly that Shakespeare's conception of Arcadia, of his shepherd-world, is very different from Greene's. The subordination of Porrus and his belongings at the close of the first part of the play pointed in this direction. And just as then Shakespeare's reshaping of the incidents did not efface Greene's version, but left it to exist by itself as a pleasant piece of narrative; so here it is significant that, while he reapportions everything else, he leaves altogether unused just the best part of Greene—the account already quoted of Porrus' setting out for the palace. To dismiss this detail by citing in explanation the obvious dramatic inconvenience of an extra scene and the absence of the shepherd's wife from among the personæ, is to miss some of the point; not only does Shakespeare omit the incident itself, but nothing even of its tone is carried over. Quite clearly this omission must be regarded as confirming the doubt raised by the treatment of the old shepherd in the earlier part of the play. Shakespeare and Greene conceive their pastoral worlds from entirely opposite points of view. Both men clothe their presentment of shepherd life with humour. But while Greene, centring the interest in Porrus and his household, works from a basis in realism, Shakespeare, thinking more of an effective foil to Perdita—"too noble for this place"— and also of the sphere best adapted for the exercise of the rogueries and accomplishments of the vagabond Autolycus, allows us glimpses of the pastoral world only in its more poetical aspects, its holiday revels and sheep-shearings. Whether or not, as Georg Brandes declares, Shakespeare was at all times "totally opposed to the realistic dramatisation of everyday scenes and characters," certainly in this instance to follow Greene, for whom such scenes and characters had a peculiar attraction, would have withdrawn far too much of our attention from Perdita to surroundings created chiefly as a background to her lovely self. This more poetical, instead of a more realistic picture of Arcadia, then, is the ultimate reason why Shakespeare would not take so much as a hint from Porrus' preparation for his visit to the king, and why he subordinated Porrus and his shepherd-life in an earlier scene. Perdita and her love for Florizel were to be shown in an almost lyrical atmosphere; the tone appropriate to a more romantic conclusion than Greene's is suggested beforehand. It is a "winter's tale" that is in the making under our eyes. The stuff of the new fabric is quarried largely from the old; but here and there a fresh piece shows through; and the design of the architect has filled both new and old with the transfiguring beauty of imagination, with the glow of his own charitable human spirit.

Rigid Airship R34

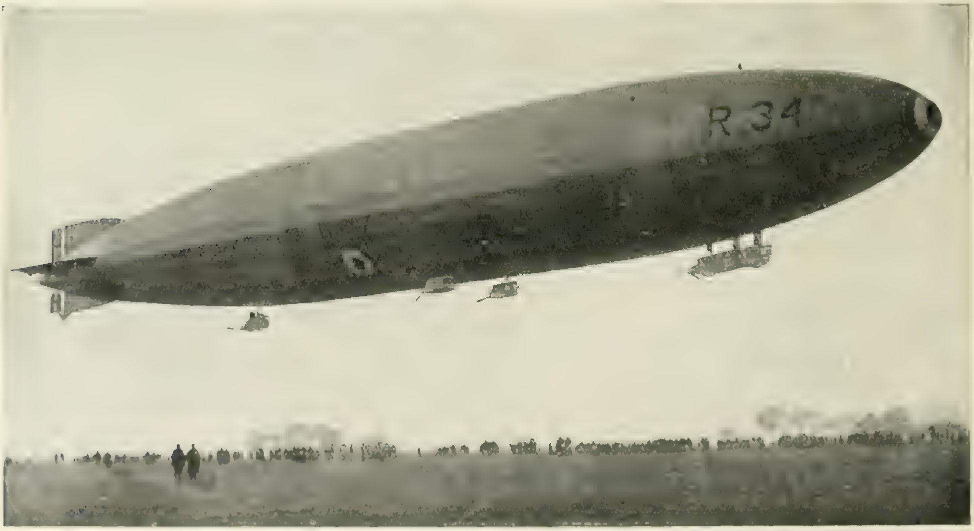
The accompanying photograph depicts the rigid airship R34, the largest British airship which has actually flown up to the present date. R34 will be for ever noteworthy in the history of aerial transport as the first airship to undertake the crossing of the Atlantic Ocean.

The photograph shows clearly the streamline shape of hull, with its blunt nose, short parallel portion of hull, and long tapering stern. The overall length of the ship is 643 feet, with a diameter of 79 feet, and an extreme height of 92 feet.

The hull is divided by the main frames into nineteen compartments, containing the gas-bags which give a volume of approximately 2,000,000 cubic feet. The gross lift works out at approximately 59½ tons, of which the total fixed weight is 33 tons, giving a disposable lift of 26½ tons.

Five cars in all are suspended from the hull framework. Forward is the control-car, with the wireless cabin adjoining it. Immediately aft of this is the forward engine-car, containing one engine, the external appearance of which suggests that the whole is one large car. Amidships are the two wing-cars, each containing one engine, while at the after end is a larger car, housing two engines and an auxiliary control position. It will thus be seen that five engines are mounted in the cars. These are all of the same type and horse-power, namely 250 horse-power Sunbeams. The maximum speed is sixty-two miles per hour. Accommodation for the crew is provided in the internal corridor which extends throughout the length of the ship.

R34 was built by Messrs. William Beardmore & Co., Ltd., and is still in commission under the Air Ministry at the Airship Station, Howden, East Yorkshire.



Weeds

By George C. Gough, A.R.C.Sc., B.Sc.

WHAT is a weed? The first dictionary I take up says " The general name of any plant that is either useless or troublesome; a plant such as grows where it is not wanted and is either of no use to man or is injurious to crops." A simpler definition would be one on the lines of a definition of dirt—matter in the wrong place. A weed is a plant in the wrong place.

It is well known that a weed of one country may be the exotic of another. An instance of this occurred some years ago when a gardener in England sent seeds of a lovely greenhouse plant in his possession to a friend in the West Indies, thinking it would grow out of doors there. The friend planted the seed and anxiously waited for the plant to appear, but to his disgust found it was one of their common weeds.

Why are weeds unwanted? Not necessarily because they are useless, for I know one fruit-plantation where dandelions were so plentiful that their rootstocks were dug up, dried, and sold for adulterating chicory, or as a substitute for it. Nor because they are always small and insignificant, for some are large, shapely, and ornamental.

There are many reasons, some apparent and some only brought to notice by scientific research. As regards the former, it is obvious that a weed takes up space which should be occupied by the crop, and thus robs the crop. Every plant, if it is to come to perfection, requires light, air, moisture, and food, but weeds struggle with them for all these. A broad-leaved weed frequently gets ahead of a cultivated plant and shades it, with the result that, in the absence of sufficient light, the latter cannot develop the green colouring-matter, or chlorophyll, without which the ordinary plant is unable to grow. The chlorophyll bodies, minute as they are, are able to build up complex compounds, like sugar, from simpler materials only under the action of sunlight, and therefore shaded plants cannot normally thrive. They become yellow and sickly. Wheat, for instance, although a vigorous plant, cannot compete with weeds. At Rothamsted, the famous experimental station, a wheat crop was once left unharvested to sow itself without further cultivation. In three years the wheat had entirely disappeared in the wilderness of grass and weeds which had sprung up.

Plants require moisture, and in taking this up by the root-hairs,[1] they also take up their food, consisting of salts dissolved in the soil-water. Weeds compete with them for this, and rob them of their due. In such cases nearly everything depends on which gets the best start, and other things being equal, the plant which gets the start soon crowds out the other. It sometimes seems as if it is the weed that always scores in this respect.

Plants require air, not only because they breathe like animals by taking in oxygen, but also because the carbon, which is the basis of all organic substances, is obtained by them from the carbon dioxide in air and worked up, as stated above, into sugar and starch, and even more complex compounds. The air with carbon dioxide is taken into all parts of the plant through tiny mouths, or " stomata," which are largely automatic in their action. They are especially thickly placed on the under-surface of leaves where they are not so liable to be choked by dust as those on the upper surface of the leaf. As plants are commonly grown for commercial purposes as close together as is consistent with health, weeds, if allowed to grow naturally take up space and rob the crop of air.

Weeds may be even more definitely harmful, as when they are parasitic[2] on a crop. Perhaps the commonest instance of this is in the case of dodder, which, although it will prey on other plants, is frequently found on clover. The dodder is a small flowering plant which entwines itself around its victims and into which it sendssuckers by which it extracts nourishment for itself. It is practically colourless and has no chlorophyll, so that it must get its complex food materials from other plants instead of manufacturing them for itself. It has flowers, and produces seeds which are harvested with the clover seed. If the clover seed is not cleaned, and the dodder separated, the latter is sown with it and its life-history is repeated on the fresh clover plant. In this instance the dodder gets its water and salts from the ground as it is rooted, but in the case of the mistletoe, the parasite gets all its water and salts from the tree on which it grows. Here, however, it manufactures some of its complex compounds by means of its light green leaves, and it is termed semi-parasitic. Some climbing weeds are injurious because they drag down the plant; such are bryony and the bindweed, or convolvulus.

A less obvious danger from weeds, and because less obvious the more dangerous, is the fact that weeds become hosts for parasites of cultivated crops. The farmer, by means of rotation, changes the crops from field to field year by year, so that one crop does not succeed the same or a similar crop. Thus potatoes are followed by wheat or oats, and these by clover and so on. A pest, therefore, which lives on potatoes has little opportunity of living if no potatoes are planted for three or four years, and it gradually dies out. If, however, weeds which are related to the potato, such as the black nightshade (*Solanum nigrum*) are allowed, or [illegible] potatoes are left to become "weeds," the pest may support and propagate itself on them, so that it remains in existence until potatoes are again cropped in the field. Cereal pests are carried over from one rotation to another by grasses which can usually support them, while weeds like charlock, wild mustard, etc., can act as hosts for turnip and cabbage pests.

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[1] Tiny microscopic hairs very near the tip of the rootlets, fresh ones being constantly formed as the rootlet grows.

[2] A parasite is either an animal or plant which lives in or on another animal or plant.

Weeds may also be poisonous, and if such are allowed to appear in pastures, they may poison stock and the farmer may suffer much financial loss. Fortunately, this is a comparatively rare occurrence in England, but in Colorado the whorled milkweed has become a very dangerous pest owing to its poisonous property. In one county a 10-acre patch of this weed was responsible for the loss in 1917 of sheep worth 20,000 dollars, and in 1918 for 18,000 dollars worth. Another case is quoted where a flock of sheep was driven over a section of the country where this weed was growing, and the sheep, being very hungry, ate with disastrous results, for it is stated that the bodies of 400 sheep had to be removed before a motor could get through.

California suffers in a different way from a weed which has been introduced from the borders of the Sahara, probably in ballast. This is the Puncture Vine (*Tribulus terrestris*), which produces a number of prostrate stems, some eight feet long. At each joint a number of burs are produced, and each bur possesses two or more sharp spines about the size of carpet tacks. These are so disposed that, whichever way the bur falls, one spine will always point upwards. These will readily puncture a bicycle tyre, and even a motor tyre if it is somewhat worn.

One does not readily associate weeds with water, although duckweed will soon be recalled to mind, as well as deeper growing plants which spoil fishing, and even navigation. The American pondweed (*Elodea canadensis*) was introduced into England and became a menace to navigation in some of our waterways, but in Florida and Texas they have even a worse pest of rivers, namely the water hyacinth. It is a beautiful aquatic plant and is highly prized for use in aquaria in some parts of America, but its spread in St. John's River and the enormous sums spent in attempting its suppression have earned it the name of the "million-dollar weed." It seems to have obtained an entrance into the river from an ornamental pond, and now not only seriously impedes river traffic, but causes an annual loss of one-fourth of the value of the logs rafted down the river. It also interferes with fishermen setting their nets, piles itself up under low bridges until the pressure has overturned them, and it collects in masses and becomes a menace to health when it decays. A curious instance of loss caused indirectly by it has recently occurred. A couple of aviators were circling over the central portion of Florida, and spied what they thought was a beautiful green meadow. They came down on it, only to find that they had alighted on a vast expanse of water hyacinths, under which were several feet of water, and it was only at great expense that the two aeroplanes were salved.

In conclusion, a word as to some of the means of getting rid of weeds. There is no very easy way, especially when they are in fields. The farmer has to do what he can when there are no crops on the ground, but this occurs rarely, except during winter, when the weeds are dormant. He therefore tries periodically and systematically to rid his fields of these pests, and takes what he calls a cleaning crop. This is usually a crop such as potatoes, turnips, or mangolds, for during most of the summer when the weeds are growing he can either turn his men in to hoe up the weeds, or else use horse- or tractor-driven machines to do the same work without damaging the crop. When grain is grown, hoeing or cultivating can only go on for a short time after the plants have appeared above ground, but in the case of one of the commonest and most harmful weeds, namely charlock, the yellow-flowered weed so obvious on badly managed farms, spraying is resorted to. Here crop and weeds are sprayed with a solution of copper sulphate (blue vitriol), which scorches and blackens the charlock as it will most plants. The question at once arises, "Why does it not kill the wheat or oats?" For the very simple reason that it runs off the upright glossy leaves of the grain, and lies on the hairy broad leaves of the weed. Sulphuric acid and ferrous sulphate (green vitriol) are also used, bracken being eradicated from grassland by the former.

Lawn sand recommended for the removal of weeds from lawns works on the same principle. It consists of sand and ammonium sulphate mixed together, and on being scattered over the lawn, lies on the broad-leaved weeds, scorching them. Ammonium sulphate, moreover, is a valuable nitrogenous manure, and when in solution, reaches the roots of the grass and stimulates growth so that grass is enabled to crowd out the exhausted weed.

Deep-seated and thick-rooted weeds, such as docks, dandelions, thistles, etc., must either be dug up where this is possible, or else continually cut down. Gradually, if the leaves which supply the food to the rootstock are not allowed to develop, the weed must die when it has used up its stored food-material. Such weeds are extremely tenacious of life, or they would have become extinct long ago.

Some weeds, especially sorrels, are characteristic of acid soils, and these will tend to disappear when land is neutralised by lime. Other weeds can be kept under by sowing down arable land to grass for a few years.

(*For Books of Reference, see p.* 50.)

Automatic Printing of Wireless Messages[1]

One of the recent developments in wireless telegraphy which is of more interest and importance to the general public than most, is the automatic printing of wireless messages in Roman type, a demonstration of which was given recently by Mr. A. A. Campbell Swinton to the Royal Society of Arts. It is interesting to recall that in January 1914 Mr. Swinton suggested that before long we might have a telegraph-printing-machine operated by wireless "in every house, telling the latest news to all the nation, as also to the newspapers, should any of these continue to survive the competition of this much more rapid method of disseminating intelligence." He thought, in other words, that it would soon be practical to operate "wirelessly" the telegraph-printing-machines which for years have been familiar occupants of London clubs and hotels. It is clear that if this could be done, there would be a great saving, not only in first cost and in expense of upkeep, but also because there would be no practical limit to the number of stations that could receive signals simultaneously from a single sending-station, so that it would cost no more to send to a thousand stations than to one. To some such an idea of the universal distribution of news might at the time have appeared fantastic, and may do so even now, but at any rate for an area comprising the British Isles and Western Europe it is now a possible thing.

It is well known that instruments connected to telegraph wires for printing messages are in daily use in newspaper offices and elsewhere. It is also well known that wireless messages can be recorded in various optical and mechanical ways, and even by an instrument analogous to a phonograph, but the ingenious method designed by Mr. F. G. Creed is the first to be adapted to printing *wireless* messages.

Suppose a message be telegraphed from London to a newspaper office in Sheffield. It is sent out of course in the ordinary Morse Code of dots and dashes; these dots and dashes may be recorded by an instrument (the receiver) at Sheffield which receives them by punching small holes in a moving strip of paper, this being simply one of several ways in which telegraphic messages are received. The strip of paper may next be passed through a second machine (the printer) which is really a typewriter controlled in an ingenious way entirely by the position of the holes in the perforated strip. In this machine the holes in the paper constituting the dots and dashes of, say, the letter F, operate a lever which causes the letter F of the typewriter to fall on a second strip of paper so that the letter is printed in Roman type. In this way all the letters and spacings in their Morse Code form are translated into letters and spacings in Roman type, and so it is that a message sent out in Morse Code from one town is received printed in words at another.

Fig. 1 will help to make this clear. The very small holes along the centre of the strip of paper are merely for the purpose of ensuring the regular motion of the strip through the instruments and have nothing to do with the signals which are denoted by the large holes.

It will be seen by comparison with the Morse signals (*b*) or (*c*) that a dot is denoted by two holes vertically over one another; a dash by two corresponding holes inclined to one another.

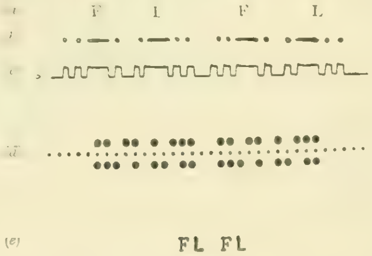

Fig. 1.

(*a*) **Letters in ordinary type.**
(*b*) Dots and dashes in Morse Code as represented in the usual way.
(*c*) The same "dots" and "dashes" recorded on a strip of paper.
(*d*) **The same signals punched on a strip of paper by the Creed receiver.**
(*e*) The letters printed by the Creed printer from the strip of paper above it.

Fig. 2 shows a photograph of the complete Creed receiving apparatus. To understand clearly the details of the working, the reader must see one in operation for himself. In brief, the working is as follows: The message to be sent is first translated into Morse Code by punching a perforated strip of paper in an apparatus with a typewriter keyboard. The message is now in the form (*d*) of Fig. 1. This paper-strip is next passed through the transmitting instrument, which sends out impulses of electric current in the dots and dashes of the Morse Code. These impulses actuate a special sending contact-maker which sends out the wireless waves.

At the receiving end the waves are picked up by a thermionic-valve receiver.[2] Their effect is amplified by an ingenious arrangement of valves. Impulses of current are thus supplied to part of the receiving apparatus known as the perforator. This is at present worked by compressed air, and is so designed that it punches on a moving strip of paper a duplicate of the arrangement of holes representing the dots and dashes which was used at the sending station for transmitting the message. When this is done the hard work is all over. It is then a comparatively simple matter to translate the Morse Code message into Roman letters with an instrument similar to the one used for several years in a newspaper office.

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[1] References: *Journal of the Royal Society of Arts*, December 3, 1920, pp. 24–36 (G. Bell & Son, 1s.); *Nature*, December 9, 1920, pp. 472–4 (Macmillan, 1s.); *Wireless Telegraphy and Telephony*, p. 150, by H. M. Dowsett (Wireless Press, 10s. 6*d*.)

[2] Described in Discovery, January 1921, p. 12.

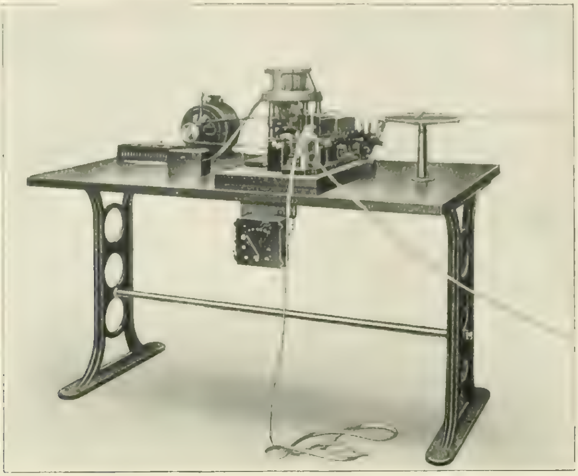
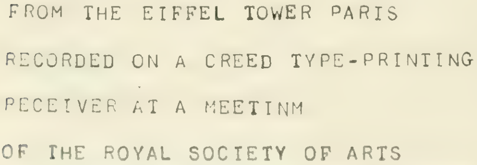


Fig. 2.

At the meeting at which Mr. Campbell Swinton demonstrated the Creed apparatus he picked up a message sent out by Horsea, near Plymouth, with the Creed receiver, printed it in Roman type, and projected the words and letters by means of a lantern on to the screen for his audience to see. Later in the evening a special message was sent him by wireless from the Eiffel Tower, and this too was automatically printed and then projected on to the screen. A facsimile reproduction of portion of this message as automatically printed is given in Fig. 3.



FROM THE EIFFEL TOWER PARIS

RECORDED ON A CREED TYPE-PRINTING

PECEIVER AT A MEETINM

OF THE ROYAL SOCIETY OF ARTS

FIG. 3.—FACSIMILE REPRODUCTION OF PORTION OF MESSAGE RECEIVED FROM PARIS, AS AUTOMATICALLY PRINTED

The new thing about these instruments is that the receiver has now been adapted to wireless transmission so that messages from places as far distant as Paris may be automatically printed. Very successful experimental work has been carried out in this way between Cologne and Aldershot, and a wireless printing equipment of this kind is to be used between a large station in the Congo Free State and Brussels. The manufacturers are at present developing an improved form of printer in which compressed air is dispensed with. The present apparatus as adapted to wireless reception is capable of a speed of transmission of 180 words a minute, which is greater than that of the printer. The improved printer, however, will be capable easily of keeping up with the receiver. Quickness of transmission and reception is of course important, not only because more message can be received in a given time, but also because each message has a better chance of being received complete without interruption by "atmospherics" or other causes.

The following are suitable books on Weeds, for further reading:

Common Weeds of Farm and Garden. By H. C. Long. (Smith Elder, 1910, 6*s.*)

Weeds of Farm Land. By Dr. W. E. Brenchley. (Longmans, 1920, 12*s.* 6*d.*)

Articles both on the subject generally and on specific weeds will be found in periodicals like the *Journal of the Ministry of Agriculture*, *Journal of the Royal Agricultural Society of England*, *Journal of the Highland Society*, etc.

Reviews of Books

English Wayfaring Life in the Middle Ages (XIVth Century). By J. J. JUSSERAND. Translated from the French by LUCY TOULMIN SMITH. (Fisher Unwin, 25s.)

It is a matter of difficulty to praise this book sufficiently, so real and delightful is the pleasure one has in reading it. It is a classic, and a classic that never bores. Its author is at present the Ambassador of France at Washington, and the author of notable works on Shakespeare, the literary history of the English people and on the English novel. The book under review appeared in French in 1884 and in English in 1889. That seems a long time ago, but age has not withered it. It appears in a second edition now revised and corrected; the notes have been brought up-to-date; new material has been included; and the whole book is beautifully produced.

It is a description of English life in the fourteenth century, a period of great interest when it became certain that England would be English and nothing else, when the language took definite shape, the principal institutions were founded, and the first masterpieces written. It was the time of the Black Death and of the Hundred Years' War.

The author has asked himself if this common life of our ancestors is possible to be discerned, possible to be reconstructed. Are the lives of kings and princes alone accessible to the historian through the remoteness of the ages? He is sure this is not so. To reach the heart of a nation, to get into touch with the four million instead of the four hundred, a patient and extended inquiry is necessary. But this can be done. In doing so it is necessary to break more or less completely with the old habit of taking the ideas of everyday life in the Middle Ages from the descriptions, the eulogies and satires of the poets. For these embellish, imagine, colour, and transform. Valuable as it is, their work needs a check, and it is from the depositions of the records of England that the real information can be obtained. In the last century thousands of documents have been printed and analysed—petitions, year-books full of reports of law-suits, statutes, and ordinances. These are, so to speak, the catacombs from which an historian can unearth and sift the riches they contain.

CHAUCER'S PARDONER.
(By kind permission of the Publisher.)

A BLIND BEGGAR CHEATED OF HIS DRINK BY HIS BOY.
(By kind permission of the Publisher.)

The book is divided into three parts. The first deals with English roads and bridges, the security of the roads, the ordinary traveller and the casual passer-by; the next with lay wayfarers, the herbalists, charlatans, minstrels, jugglers, messengers, and pedlars, the wandering workmen, and the outlaws; the last with religious wayfarers, the pardoners, the wandering preachers and friars, the pilgrims, and the crusaders.

The whole is written by a man who is deeply in love with the times and the men he is describing. There are about seventy illustrations, some of them photographs, others reproductions of drawings in old manuscripts, which are distributed through the book not to give a reader an occasional rest but to illuminate the topic under discussion and to stimulate interest. Another excellent point about this book is that by means of unobtrusive footnotes the author gives chapter and verse for most of his statements. It is not only for this that references are valuable, but also for the fact that at any stage the interested reader is told exactly the book or series of books which he can rely upon as being best for further study. But footnotes and illustrations and excellence in printing cannot make a book; they can but embellish it. Its charm must be ascribed to other things, to the interest of the subject to every Englishman, and to the kindly, scholarly, and witty manner in which the whole tale is told.

One may open the book almost at any page to find pleasant and interesting reading.

"When a robber, murderer, or other evil-doer shall fly into any church upon his confession of felony, the coroner shall cause the adjuration to be made thus: Let the felon be brought to the church door, and there be assigned unto him a port, near or far off, and a time appointed for him to go out of the realm, so that in going towards that port he carry a cross in his hand, and that he go [illegible] of the king's highway neither on the right hand nor on the left, but that he keep it always until he shall be gone out of the land." Dover was the port oftenest assigned to these funny fellows. The time allotted to clear out was often ridiculously, and no doubt purposely, short. "The distance from York to Dover over London Bridge was nearly 270 miles, and there are several entries of eight days being the allotted time, thus maintaining a rate of over thirty-three miles a day." This, barefooted, was excellent going; the felon must have indeed been sorry for himself.

The book is essentially one to buy, to read, and to keep. It is always delightful. Those who have not read it are to be congratulated on the happiness that awaits them.

P. K. F.

(*a*) *Secrets of Earth and Sea.* By Sir RAY LANKESTER, K.C.B., F.R.S. (Methuen, 8*s.* 6*d.*)

(*b*) *The World of Sound.* By Prof. Sir WILLIAM BRAGG, K.B.E., F.R.S. (G. Bell & Sons, 6*s.*)

These books have this in common, that each is written by a Fellow of the Royal Society, and that each may be heartily recommended to readers. They are just the kind of book that one is glad to have an opportunity of reviewing, for they are informed, clearly-written, understandable, and really give one an interest in the things the writers are dealing with. It is not often that the Royal Society writes so that those who never can become Fellows, or at best can become (in Mr. Wells's phrase) Fellows of the Royal Society, "in the sight of God," can follow its line of thought, or understand and remember the different things it writes about. But it happens sometimes, and here before us are two excellent cases in point.

(*a*) Sir Ray Lankester occupies in science a position not dissimilar to Mr. Gosse's in the world of letters. He has had a considerable and happy past; he keeps in touch with the present day, and he has obtained and retains the respect of his brethren.

He is always well-informed and he writes interestingly. This volume, like its predecessors, *Science from an Easy Chair* (Series I and Series II), and *Diversions of a Naturalist*, is mainly a revision and reprint of articles dealing with scientific matters published in daily or weekly journals.

He writes of the earliest picture in the world—a carving of certain representations of animals on a cylindrical piece of the antler of a red deer found in the South of France nearly fifty years ago,—of the art of prehistoric man, of portraits of mammoths made by men who saw them twenty-five to fifty thousand years ago.

A chapter is devoted to a graphic account of Vesuvius in eruption in 1871 and 1872, when the author made ascents with different friends. In another he deals with the blue colour of water and of other things such as the eyes, the sky, and glaciers. In writing on the biggest beast, the *Gigantosaurus*, he is loth to admit that antiquity has beaten the present age, for, as he explains, this biggest of quadrupeds lived probably in the sea, and is therefore to be compared with the whale and not the elephant of the present day.

There are also interesting chapters on Species, the Cross-breeding of Races, Suspended Animation, the Swastika, Coal, and the Story of Lime-juice and Scurvy.

(*b*) Sir William Bragg's book consists of six lectures delivered before a juvenile auditory at the Royal Institution at Christmas 1919. Its substance has already appeared in a series of articles in our contemporary *Conquest*. The author is known not only as an investigator of the first class but also as an exponent of physical science, whether the subject lectured on be highly technical or not, who has few equals at the present time. This book is certainly a model of popular exposition. A great number of experiments of a very interesting type are described, and they are well illustrated by drawings and diagrams.

The opening lecture deals with sound in a general way. Thereafter, sounds in music, sounds of the town, sounds of the country, sounds of the sea, and lastly, sounds in war are described; and whether Professor Bragg is explaining why there is a note given out when the wind blows past a wire, or in what way the hydrophone was used during the war to locate explosions at sea, he is always delightful and easily understood. No one is so clever that he cannot learn a very great deal from this book, or fail to take a greater interest in the sounds of everyday life. Those, too, who lament the decay of English prose, and fear that no scientist of to-day has carried the art of writing beyond the elementary stage, will find in this book a clear and persuasive style that will remind them of that of Tyndall or Faraday or some other idol of the past whom they admire.

A. S. R.

OTHER BOOKS RECEIVED

Personal Aspects of Jane Austen. By MARY A. AUSTEN-LEIGH. (John Murray, 9*s.*)

General Practice and X-rays. A Handbook for the General Practitioner and Student. By A. VANCE KNOX, M.B., and ROBERT KNOX, M.D., C.M. (A. & C. Black, 15*s.*)

The Antiquaries' Journal, vol. i, No. 1. January 1921. (Oxford University Press, 5*s.*)

Territory in Bird Life. By H. ELIOT HOWARD. (John Murray, 21*s.*)

A Textbook of Plant Biology. By W. NEILSON JONES, M.A., F.L.S., and M. C. RAYNER, D.Sc. (Methuen, 7*s.*)

British Plants: their Biology and Ecology. By J. F. BEVIS, B.A., B.Sc., and H. J. JEFFERY, A.R.C.Sc., F.L.S. (Methuen, 7*s.* 6*d.*)

A Handbook of Indian Art. Architecture—Sculpture—Painting. By E. B. HAVELL. (John Murray, 25*s.*)

My Electrical Workshop. By F. T. ADDYMAN. (Wireless Press, 7*s.*)

DISCOVERY

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Editorial Notes

THERE is promise of a great adventure next year. A joint committee of the Alpine Club and of the Royal Geographical Society has been formed to organise an expedition to climb Mount Everest, the highest mountain in the world. It is proposed[1] to send out a reconnaissance party to Tibet this year to make a real, thorough survey of the whole situation, to find out as much as possible about the country around Everest, about the mountain itself, and about the climatic conditions that prevail in those promiscuous parts, and next year if all goes well to send out a climbing party. It is a big undertaking, but so little is really known of the geography of that part of the world that a thorough reconnaissance is an absolutely essential preliminary to the full assault of the mountain.

* * * * *

If all goes well this year, then, we may reasonably hope that Everest may be climbed next year. Difficulties in the past have been of two kinds, political and natural. The former have at last been overcome, and the latter may now be closely and scientifically studied. High risks will have to be run and uncommonly severe hardships endured—risks from icy slopes, from rocky precipices, and avalanches; hardships from intense cold, from terrific winds, and from blinding snowstorms. Even were all these difficulties magically annulled while the climbing party were making the ascent, there would still remain the grave difficulties due to the diminished pressure of air at high elevations. Everest is 29,002 feet high (as we learned at school), and no man has ascended a mountain within 4,000 feet of this height. No man knows, therefore, the capacity of a human being to stand great exertion at this altitude. It can be learned by actual experience only.

* * * * *

The approaches to the mountain are as yet unknown to Europeans. Few, indeed, have ever seen the peak. But the most likely approach seems to be from the Tibet side. Colonel Howard Bury, who has recently been out there and who has been appointed Chief of the Expedition, recommends the route from Darjeeling via Phari, Kampa Dzong, and Tingri Dzong. On this route pack transport of mules, ponies, or yaks could be used the whole way. The members of the reconnaissance party going out this year can test this point and find out what pack animals can thrive best, work best, be most sure-footed, and stand the altitude with least fatigue. They can also decide what natives are most likely to be of the greatest assistance in the climb. They will have to explore with the greatest care all the approaches, and to examine, photograph, and map the mountain itself in fullest detail. They have a piece of work to do which demands high physical, moral, and scientific qualities.

* * * * *

In this work it is not considered probable that the aeroplane will be of much assistance. A reconnaissance of the southern slopes of the mountain could be made by flying up the Arun valley from the plains of India, but the difficulty of this is the provision of an aerodrome at the foot of the hills. There is none there now. The nearest is at Calcutta or Allahabad, and funds for building a nearer one are not available. Reconnaissance by aeroplane from the Tibet side of the mountain is prevented for another reason. For in the high land of that country the density of the atmosphere is only about one-half of that at sea-level, and no aeroplane of the present type would rise from the ground.

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[1] See *The Geographical Journal*, February, 1921, pp. 73, 121.

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However, some of the difficulties that seem to face the party at present may disappear: others, unforeseen, may arise. It would not be an adventure if everything was seen or foreseen. The expedition has the cordial co-operation of the Government of India and more particularly of the Surveyor-General. With this assistance and that of the two Societies which are going to find the £10,000 necessary for the work of two years, the expedition starts under better auspices than have favoured any previous attempt to climb a high Himalayan peak. Everyone who can see the importance of any further step towards the mastery of our surroundings will wish this expedition success.

* * * * *

I have lately looked through a very able book[1] in which water-divining, one of the subjects in which I am interested, is spoken of rather disrespectfully. A book like this which deals with Spiritism is very timely, for we are getting rather tired of those people who give such profuse *material* details of the "life beyond" in the Sunday newspapers and the popular monthly magazines. Dr. Culpin in this book attempts to give an explanation of it all in terms of recent work on psychology. "My object in writing this book," he says in the preface—and it is a good thing to have an object in writing a book nowadays—"is to present an explanation of so-called occult phenomena, concerning which credulity is still as busy as in the days of witchcraft. The producers of these phenomena have been exposed efficiently and often, but their supporters are as active as ever, and show a simple faith which is more convincing than any argument. Moreover, the producers themselves—mediums, clairvoyants, water-diviners, seers, or whatever they may be—are sometimes of such apparent honesty and simplicity that disbelief seems almost a sacrilege; therefore part of my aim is to show how a man believing firmly in his own honesty may yet practise elaborate trickery and deceit."

* * * * *

He then introduces the views on the subjects of the unconscious, the formation of complexes, and of forgetting and repression which are held by most psychologists to-day. With these I do not propose to deal. But if one understands such subjects of the new psychology as "dissociation," "suggestion," and the "unconscious," one may easily follow Dr. Culpin as he expounds his views. I am not sure, however, that Dr. Culpin's explanation of water-divining is as convincing as that of some of the other subjects with which he deals. I think that two subjects, water-divining and telepathy, are rather held in disrepute because they are associated with the quackery of spiritism.

* * * * *

Dr. Culpin looks upon the water-diviner as a species of clown whose object in divining is primarily to show off to an admiring audience, to behave in a queer way that he may become a centre of interest. The audience is there to encourage him, and to slap him on the back when he apparently achieves a success. It has a peculiar kind of memory, for while it remembers the cases successfully demonstrated, it speedily forgets the cases of failure. So does the water-diviner. He himself is not consciously deceiving his audience. He is no doubt quite in earnest: but he is unconsciously a deceiver. Originally he must have known how evil it is to deceive others, but this unpleasant thought has been carefully repressed and hence forgotten, so that the knowledge of his deceit does not occur to him in the conscious state, and an affirmation on his part that he is acting honestly is quite worthless. But why does he do all this? For notoriety, to have power, to feel superior, to be something exceptional. And why does the twig, which in the hands of the water-diviner twists upwards when he locates the water, move as it does? Because the diviner, while apparently holding it down for all he is worth, really has it in such a sensitive position that a very little movement actually forces it up. This little movement is supplied unconsciously by a desire to trick and no doubt by a clever appreciation of impressions received from the audience.

* * * * *

Now this is a very ingenious theory, and even although I cannot state it as clearly as the author does, his main point, that water-divining is a fraud, is indicated sufficiently. And so the argument falls to the ground if the water-diviner really does know when underground water is below him and when it is not. I think the explanation which agrees most closely with the facts is to say that the water-diviner has a genuine gift which is a new or rare *sense*. He does find water; he can trace underground streams accurately. When he says water is in a certain place, it is there; when he denies this, it is not there. Give him an area to investigate and sufficient time to work and he can map the underground streams, show their relation to, or independence of, each other and to springs. Sink your shaft at suitable points of the underground stream and there, sure enough, is the water. In the light of such facts, if one regards the diviner as an honest man but unconsciously a trickster, one may apply the same argument to any investigator. One may deny, for example, the reality of atoms and regard the theory and experiment connected with them as an ingenious superstition in which many apparently excellent people seemingly believe and about which they are apparently very consistent, no doubt because it suits their book, attracts attention to themselves, and provides them with very nice posts at the Universities!

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[1] *Spiritualism and the New Psychology.* By Millais Culpin. (Arnold, 6s.)

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If one believes, as most psychologists do, that we are only partially awake, or that we are only now emerging from what is analogous to a pre-natal sleep, one need not get unduly excited because some men seem to have gifts which the rest of us lack. If water-divining is some kind of sense it must necessarily be a difficult thing to investigate. All senses are. Think how hard it would be for a man with sight to explain his gift to a blind world. How wonderful a man with a sense of smell would appear to us, supposing that none of us could smell! He could tell, for example, liquid ammonia from alcohol or from water correctly every time, without shaking them, tasting them, weighing them, or doing chemical analyses of them, as we should require to do, simply by bringing his nose into the vicinity of each in turn. We, the lookers-on, might reasonably be sceptical, might wonder what the nose had to do with it, might suspect there was some collusion between the smeller and the man who knew which liquid was which. Twenty plausible hypotheses on an assumption that the smeller was tricking us in some way might be invented, yet the simpler explanation that the man possessed a gift which we lacked would be considered revolutionary, or, indeed, might never occur to anyone at all.

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Telepathy or thought-transference is another subject concerning the genuineness of which there is often fierce discussion. Many physiologists and psychologists do not believe in it at all. Many, however, regard it as one of the functions of the unconscious mind. Freud and several other workers of importance ignore its existence, but there seems no escape from the view that it occupies a small but not unimportant place in the list of functions of the unconscious mind. A simple but illuminating description of telepathic power is given by Dr. Paul Bousfield of Harley Street in his recent book.[1]

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"I am fortunate in possessing a friend who has developed telepathic powers to a considerable degree, and from boyhood upwards my relatives and I have had every opportunity of testing his powers under our own conditions. We have grown to look upon his powers as something more or less ordinary, and indeed have devised a new drawing-room game based upon them. I wish to give here one or two of the experiments which have taken place, not once only but very many times. In the following paragraphs I refer to him as Mr. X.

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"Mr. X. is sent into an adjoining room quite out of earshot,[1] while we then decide upon some trivial action which he shall perform, such as picking up the poker and carrying it across the room and presenting it to Mrs. B. Mr. X., blindfolded, is now called into the room. Nobody touches him. Everyone sits perfectly quiet, no sound or word of any kind is spoken. Those sitting in the room now 'will' his *movements*, i.e. first that he shall walk to the right spot where lies the poker, then that he shall stoop, then stretch out his arm in the right direction, and so forth. As a rule, with very little hesitation, the whole performance is gone through without a hitch. Such experiments, however, must be fairly simple in character; thus, while we can make Mr. X. walk to the piano, open it and sit down, we have never succeeded in conveying to his mind a particular tune which we wish him to play. During these experiments he describes his own part as consisting in 'making his mind a blank' and moving as if under compulsion. As the sitters are not always the same on all occasions, there is no possibility of any system of signs.

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"A variant of this experiment is as follows: two groups of persons are formed. One group settles upon one set of actions, say, that Mr. X. shall take the poker and present it to Mrs. B. The other group selects a different set of actions—perhaps that he shall remove a hairpin from the head of Mrs. C. and place it on a given chair. When Mr. X. comes in a contest thus takes place. Perhaps, after a pause, the concentrated efforts of the first group succeed in getting him to pick up the poker. There may be then a feeling of triumph and relief in that group, with a consequent momentary relaxation of concentration. Immediately this takes place Mr. X. will perform part of the plan formed by the second group; he will rush to the chair and place the poker on the chair where the hairpin should have been placed. A variety of similar experiments have taken place.

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"Perhaps the most convincing and at the same time one of the simplest experiments is as follows, and it is one which absolutely prevents any trickery whatsoever. Mr. X. sits in a chair with his back to me (or any suitable person); he is at one side of a room and I am at the other. There need be no other person in the room. I take a pack of cards, shuffle it, look at one card, concentrate my mind upon it, and say simply the one word 'Now!' Mr. X. at the other side of the room, with his back to me (or blindfolded) names the card in detail, thus, 'Queen of Hearts.' And so we proceed through the whole pack. The only word spoken is 'Now!' Mr. X. never gets all the cards right; frequently there are mistakes, but the majority of the cards are named correctly. To anyone who has performed such experiments as these, time after time, there can be no doubt about the existence of telepathy, and that it merits a place in the functions of the unconscious mind . . . its exact method of action is as yet veiled from us."

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[1] *The Elements of Practical Psycho-Analysis.* By Paul Bousfield, M.R.C.S., L.R.C.P. (Kegan Paul, 10*s.* 6*d.*)

[1] An ingenious explanation of telepathy in a case like this is that the man outside really, but unconsciously, hears what those inside are saying.

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With his pilot-house windows screened by heavy canvas which effectively shut out the surrounding view, Commander Norton of the *Semmes*, guided only by the sound from electric waves thrown out by a submerged cable, recently piloted his vessel from near the Ambrose Lighthouse for sixteen miles along the Channel of New York Harbour to Fort Lafayette in the Narrows. The feat marked a successful test of an invention by which it is hoped to enable liners and warships to make their way into harbour to their Hudson or East River docks or anchorage, in defiance of the densest fog or the darkest nights made darker by falling snow.

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No better time for the experiment could have been hit upon, as the importance of the invention is impressed on shipping men and landsmen alike by the fact that recently the Atlantic Fleet was held up for three days outside Sandy Hook by a fog, which also delayed Transatlantic liners for a considerable time. The cable at the bottom of the fairway was charged from the fort. Two electric coils had been set above the water-line of the *Semmes* on each side of the bow, and wires extended from them into an amplifier on the bridge. From the amplifier, telephone receivers had been carried to various parts of the vessel, and with these clamped to their ears several persons were able to hear the sounds given by the cables.

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As the destroyer approached the latter at a sixteen knot speed a faint clicking of the code word "Navy" was heard. It grew louder first on the port side and then on the starboard side as the vessel steered to left or right of the cable, and Commander Norton had no trouble in following the line through the sounds, which increased in volume or grew fainter according to whether the *Semmes* was headed along it or from it.

The Ambrose Channel is 700 yards inside, but in places the shores are as much as 5,000 yards apart, so that in foggy weather a large vessel risks going aground if it ventures to thread the fairway. It is understood that the invention will be recommended for adoption, and that the Navy will lay similar cables in other harbour entrances, afterwards turning them over to the lighthouse service. It is estimated that the cable will save thousands of pounds now caused by delays to shipping through weather conditions.

Land and Sea in Greek Life—II

By W. R. Halliday, B.A., B.Litt.

Professor of Ancient History in the University of Liverpool

(*Continued from the January No., p.* 18)

In the first part of this paper we noticed how the ancestors of the Greeks ceased to be a pastoral and became an agricultural people. They ceased to reckon their wealth in oxen, and assessed their incomes in bushels of produce. Their diet underwent a corresponding change. The Homeric chieftains ate large quantities of meat, but the Greeks of historical times lived almost entirely upon cereals, vegetables, and fish. Meat was only eaten when there was a sacrifice; and when Xenophon's men, marching through the desert to Cunaxa,[1] were obliged for lack of other food to adopt a meat diet, they grumbled at what they felt to be a serious hardship. But though Greece is emphatically not a land of pasture, neither is it naturally a corn-producing country.[2] The area of arable land in its little plains is very limited; above the limestone there is but a shallow layer of soil at best, and this is light and stony and yields but a poor return. In consequence, when the adoption of a peaceful settled existence resulted in a rapidly increasing population, there was soon no longer sufficient land for everyone to be a farmer; and, more serious still, the land belonging to the community no longer produced sufficient corn to feed all its members. Two obvious solutions of the economic problem suggest themselves at once: either the area of the land of the community must be increased or the number of mouths decreased. Sparta, like Rome, solved the problem in part by the conquest of more land, but it is obvious that this solution is not universally possible, for the area of land belonging to one community can only be increased at the expense of another. The second alternative was therefore widely adopted, and overpopulation made the Greeks into sailors and colonisers. Some, like the mountaineers of Arcadia, went off to serve abroad as mercenaries. As early as the seventh century B.C. Ionian and Carian mercenaries were the deciding factor in the Egyptian revolution, which threw off the Assyrian yoke and put Psammetichus I on the throne. Greek merchants went wherever there was hope of gain, and Psammetichus' soldiers were followed by the merchants of Naucratis, the Shanghai of Egypt. When Cambyses invaded Egypt in 525 B.C., Greek merchants were among his camp followers. In Herodotus' day the Greek was ubiquitous, and throughout the Oriental lands in which the historian so widely travelled, he was clearly never at a loss for an interpreter. And besides this dispersion by the emigration of individuals, there were the organised settlements sent out by the Greek States of Asia and the Balkan Peninsula. Greek colonies spread all round the Mediterranean from the Black Sea to Marseilles until, as Cicero expressed it, the world had a Greek fringe.

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[1] 401 B.C.

[2] Baedeker's statistics for Modern Greece (1909) give 8 per cent. pasture, 18 per cent. arable, 9 per cent. forest, 65 per cent. mountain land. The area of forest was larger in antiquity, and deforestation has no doubt assisted erosion and diminished the rainfall.

But even with a diminished number of mouths there was not enough corn to feed the Greeks who stayed at home; and of course the development of commerce implies the growth of a non-farming population for which provision must be made. It was inevitable, therefore, that the Greeks should become dependent upon imported corn. For this they made the necessary payment partly by the profits of the carrying trade, and partly by the export of manufactures or commodities for the production of which their country was economically suitable. The most valuable of agricultural gifts was that of Athena, the goddess of the olive. The olive thrives in the poor soil of Greece, and demands comparatively little care. Its product was indispensable in ancient life, for olive oil took the place of our butter, soap, and illuminants. Even the refuse after the oil has been squeezed was valuable then, as now, for cattle food. There is no waste about the olive. The vine, too, can be grown with profit, particularly in the volcanic soil of the islands. Malvoisie derived its name from a district in Crete, and Modern Europe drinks more Greek wine than perhaps it knows.

The natural tendency, then, is for the Greeks to develop the culture of the vine and olive, and to pay for imported corn with the profits of the export of wine and oil. But if you are sending wine and oil by freight a receptacle is necessary, and in consequence the export of these goods tended to stimulate the pottery-industry. Of course cargo in bulk was not sent in the highly decorated painted ware, but in big Ali Baba jars. It can hardly be doubted, however, that the pottery trade as a whole received a stimulus. The finely painted wares were destined mainly for the Etruscan market, to be used as funerary furniture in the tombs of the wealthy; but Herodotus tells us rather an interesting thing about the wine jars. A large number of jars of Greek wine were yearly imported by Egypt. Of these the "empties" were collected, and were used on the waterless caravan route through the eastern desert to form artificial water depots.

MELOS. LIMESTONE AND SCRUB, SHOWING THE POOR NATURE OF THE SOIL.

The conditions of early navigation were difficult, although Nature, as we have seen, had provided exceptional facilities in the chains of islands which gave both shelter and guidance to the early mariner. Old Hesiod knows the rules for seafaring, but is not very enthusiastic about it as a profession. It is too chancy and the risk is too great. His advice, however, to the young adventurer, who refuses to be warned off, is perfectly sound; his rules as to seasons hold good to-day, and could be illustrated from the weekly statistics of the movements of sailing vessels, which it was lately my duty to collect and send to Mudros. There are two seasons when sailing is possible. In the summer there is nothing to fear except squalls, and the prevailing wind is northerly. For the Etesian winds not only cool the torrid heat, but provide a steady trade-wind, and Plato has described how with their advent come the merchants "flying over sea in springtime like birds of passage to all foreign countries." The early spring season is much less reliable; heavy gales occur and the adventurer may suffer shipwreck. The worst time of all is the autumn, when the rains begin. Then you must avoid lingering at sea, or you may suffer like St. Paul. The winter was a close time for navigation; ships were hauled up and the tackle stored by the fire. This seasonal limitation remained a characteristic of navigation in classical times. When Julius Cæsar, after the defeat of Pompey, became involved in Egypt in 48 B.C., no news of him was received in Rome throughout the winter. And here a small point may be noticed. Many of the Greek harbours point south and are exposed to southerly gales (e.g. the harbour of ancient Samos). Southerly gales, however, are mainly to be feared in the winter, when the ships in ancient times were safely hauled up upon terra firma. Short of beaching his ship for the winter, the skipper of St. Paul's vessel had no choice of remaining in "the Fair Havens." It is an admirable little harbour for a small vessel (as upon one occasion at least a U-boat commander appreciated) when the wind is in another quarter, but its mouth lies open to the prevailing gales of winter.

A VIEW OF THE COAST: CLIFFS AND SCRUB ON THE WEST SIDE OF CORFU.

Despite the difficulties of early navigation, Greek explorers persevered, and in the Eastern Mediterranean they wrested the monopoly of the carrying trade from the Phœnicians. In the west Carthage proved too strong a rival. Tartessus in Spain was sporadically visited by Æginetans, Phocæans, and Samians; but Marseilles remained the isolated western limit of Greek colonisation, and attempts to found intermediate posts were frustrated by the Carthaginian–Etruscan alliance. "The Silent Trade" of the West African coast[1] and the passage to the Tin Islands remained wholly in Carthaginian hands. The secrets of their charts were jealously guarded by the Semites, and the skippers of other nationalities whom they caught beyond the Straits of Gibraltar were made to walk the plank.

Apart from the Carthaginians, life upon the sea was pretty lawless—commerce and piracy went hand in hand. "I am the servant of the lord god of war," sang the adventurer Archilochus in the middle of the seventh century, "and I know the lovely gifts of the Muses. In my spear is kneaded bread, in my spear is wine of Ismarus, and I lie upon my spear as I drink." The merchantmen of a rival state were fair game, and competition was not restricted to peaceful rivalry. The smaller islands were nests of wreckers, and the tale of wrecking goes back to the legendary times of the return from Troy, when Nauplius lured the Greeks upon the rocks by means of misleading flares.

The disorder upon the high seas was naturally increased by the Persian conquest of the Greeks of Asia in the sixth century. Refugees and desperate exiles were driven to homeless wandering or preferred the freedom of adventure to the burden of a foreign yoke. For this ferment the Western Mediterranean provided to some extent a safety-valve, and Greek adventurers in Carthaginian waters played a rôle comparable to that of our Elizabethan sailors in the Spanish Main. That stout sea captain, Dionysius the Phocæan, when, thanks to divided leadership and the desertion of traitors, the cause of the Ionian rebels was irretrievably lost at Lade in 494, escaped with the ships under his command, and after a raid upon Phœnician shipping in the Levant, established himself in Sicilian waters as a patriotic pirate, plundering Carthaginians and Etruscans, but not his own countrymen.

The Mediterranean, indeed, with its numerous islands, has always been a prey to piracy. Whatever the political shortcomings of Athenian imperialism, the Athenian Empire conferred no small material benefit upon Greek commerce as a whole by effectively policing the seas and suppressing, as at Scyros in 474, the pirate strongholds. For up to the nineteenth century there have been but two periods when the sea routes of the

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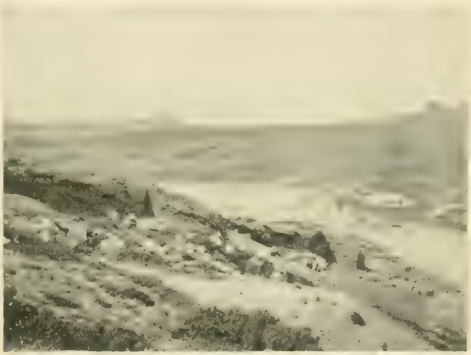
[1] Herodotus (iv. 196) describes, but from hearsay only, how the Carthaginian merchants laid their goods upon the beach and re-embarked after making a smoke signal. The natives then laid gold beside the goods and retired. If the Carthaginians did not think it sufficient, they returned again to their ships and remained at anchor while the natives added to the gold. When a fair price was reached the Carthaginians took the gold, left the goods, and sailed away. This method of silent trading finds analogies to-day; see, for instance, the account of the barter between the Hawai-u and Kuku-kuku peoples in the Official Report for Papua, 1907 (Report of H. L. Griffin, R.M. Gulf Division).

Eastern Mediterranean have been free from pirates: the first half of the fifth century under the rule of Athens, and under Roman rule, after Pompey had cleared the seas in 67 B.C. And to-day the same phenomenon may be remarked which Thucydides noticed in the fifth century. Before his time, he tells us, the coastal towns, for fear of pirates, were built not at the harbour's edge, but upon the hills behind; but since the Athenian Empire had restored security, the towns were creeping down to the obvious convenience of the water's edge. In mediæval times insecurity once more drove the villages to the hills, and it is only in the nineteenth century that peace upon the high seas once more permitted them to leave "the Castro" for the harbour. The port of Syra provides a good example. The older villages crown the twin hills behind the harbour, and every building in the modern port, which has grown up at the water's edge, is subsequent in date to the liberation of Greece.[1]

In the fifth century B.C. Athens became the central mart of the world's trade. The premier commercial powers of the sixth century had suffered from the advance of Persia, and though the states of the Asia Minor coast and islands had been "liberated," they had in fact exchanged a foreign for an Athenian yoke; while the hostile relations existing between Persia and Greece injuriously affected communities whose commercial greatness had been based upon their position at the terminal points at which the Eastern caravan routes debouched. Ionian commerce, no less than Ionian philosophy and letters, migrated in the fifth century to Athens. Ancient trade consisted principally of luxuries and necessaries; the intermediate class of goods, which may be called dispensable comforts or conveniences, and which form, I imagine, the bulk of modern commerce, was then but little in evidence. The Greek market, like Solomon's, is concerned mainly with "peacocks, apes, and ivories," or with necessaries like timber, oil, and corn, which, it will be remembered, formed the material of the Jewish king's deal with Hiram of Tyre.[2] For the merchant luxuries brought in the larger profit; the most valuable commodities, says Herodotus, inverting the true significance of the fact, are to be found in the remotest parts of the world. But from the State's point of view necessaries, which include timber, essential for a shipping power, metals, and corn, are more important. To ensure a supply and to control the distribution of vital necessaries, the State established strict control. The merchant of an Athenian vessel was compelled by law to load corn as part of his return cargo. At the Dardanelles the destination of cornships was controlled by Athenian officials, and Pontic merchants selling corn in any other market without Athenian permission were liable to the death penalty. State officials took charge of the delivery at the Piræus and regulated the distribution of supplies to retail dealers.

That Athens was right in regarding the control of the Russian corn trade of vital importance was shown by events. At the battle of Ægospotami in 405 B.C. she lost control of the Dardanelles, and her starvation automatically followed.

More profitable to the private speculator was the trade in luxuries. Carpets and embroideries from Carthage, metalware from Etruria, ivory from Africa, goodly Babylonitish garments from the East, and possibly even silk from China, found a way to the Piræus; and the peach, the pheasant, and the peacock made their appearance in Greece in the fifth century. Peacocks were first introduced by Pyrilampes, who had been an ambassador in Persia. They attracted great attention; "Is it a peacock or a bird?" asks a character in Aristophanes at a time when the novelty was in its first bloom; but even in the next generation people came from all over Greece to see them, and upon set days the aviary was thrown open to the inquisitive public.



VIEW OF THE COUNTRYSIDE AT SUNIUM ON THE WEST SIDE OF ATTICA.

The standard of luxury was naturally raised, and if life at the close of the century was hardly comfortable in a modern sense, it was considerably more ostentatious than at the beginning. The change, however, in the material standard of living was incommensurate with the spiritual change wrought by the expansion of commerce, and the vistas which travel and exploration opened up. We know what the discovery of America did for Europe; a similar broadening of the horizon gave new energy to Greek art and thought. Æschylus no less than Herodotus is moved by the new geography.

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[1] Similarly in the western end of Cos the now deserted castle of the Rhodian knights at Antimachia was inhabited for security in recent times. I was assured that the modern villages in its vicinity have all come into existence since the Crimean War.

[2] 1 Kings, v.

Travellers' tales from the ends of the world now took the place of the early sailors' yarns. Scylla was no longer to be met with round the Mediterranean coasts as in the Bronze Age or in the days of Homer.[1] But though the boundaries of the world had been pushed back, travellers had still tales to tell of their remoter edges. Above the Issedonians, Herodotus tells us simply, dwell the Arimaspians, who have only one eye, and the gryphons who guard the gold. Or, as typical of the new type of wonder-tale, take his account of cinnamon. "We Greeks," he says, "get our cinnamon from the Phœnicians, but it is originally collected by the Arabians. There is an enormous bird in Arabia, which builds its nests of mud and cinnamon logs on the tops of inaccessible precipices. The Arabians get at them in this way. They put out whole carcases of oxen, which the bird carries off to the nest; the added weight is too much for the structure; down falls the nest, and the ingenious Arabians pick up the debris. And that is how we get our cinnamon."

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[1] Homer, *Odyssey*, ix–xii, with its cannibals, sirens, clashing rocks, and the western end of the world where dwell the dead, is a collection of sailors' yarns. In a narrow strait between two cliffs on the one hand was a whirlpool, and on the other a sheer precipice halfway up which was a hole so deep and high that an arrow would not reach. Here lurked Scylla. "Her voice, indeed, is no greater than the voice of a new-born puppy, but a dreadful monster is she, nor would any look on her gladly, not if he were a god that met her. Verily she hath twelve feet all dangling down, and six necks exceeding long, and on each a hideous head, and therein three rows of teeth set thick and close full of black death. Up to her middle is she sunk far down in the hollow cave, but forth she holds her heads from the dreadful gulf, and there she fishes, swooping down from the rock for dolphin or sea-dogs, or whatso greater beast she may anywhere take." Sir Arthur Evans has published a clay sealing of the Bronze Age which depicts a man in a boat being attacked by a dog-headed sea-monster. *Journal of Hellenic Studies*, xxxii, p. 291.

Neglected Aspects of Mathematics

By C. A. Stewart, M.A.

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Of those who do not understand Pure Mathematics, some are respectful as if entering a shrine; but others, of the baser sort, are contemptuous. These have found the way of progress dark and difficult. Their guides, perhaps, have not inspired them, and symbolism seems far removed from the needs of ordinary human life. They deny that it can have an ideal, that it can have any claim to beauty. They admit that it has some purpose in its application to the practical affairs of life, but that it can have an end in itself is incomprehensible. It is associated in the minds of some with the removing of interminable brackets, and with the chasing of elusive unknowns. Since it deals usually with the variable and not with the particular, and since it is concerned more with deductions from data than with the truth of these data, it has been described as the subject "in which we never know what we are talking about, nor whether what we are saying is true."[1] It is usually considered unwise to express lack of appreciation of the works of a great painter or sculptor or poet, but there have been men of intellect who not only have expressed ignorance of scientific method, but have also been inclined to exaggerate that ignorance. The questions that such a criticism of the subject naturally raises are: Is this hostility justified? Can it be wholly attributed to feebleness of insight? For it is possible that although Mathematics need not fail to supply the necessary stimulus to intellectual thoughts and aspirations, yet its exponents may fail in the interpretation and expression of its ideals; and it must be admitted that the way of mathematical learning can be, and often is, a dull and cheerless one, especially for him whose aptitude is weak. The inherent beauty of mathematical reasoning may be marred by methods that are brutal, and its outlook warped by unduly insisting on the necessity of the moment.

My object in this article is to consider the position of the mathematician in two of his possible moods—during his moments of leisure and during his moments of reflection. Are there pleasant bypaths of mathematical thought and speculation for him to wander in during his hour of freedom? Are there fields of activity within its sphere that can fitly be described as inherently attractive? And is there scope in mathematical teaching for the occasional introduction of what is distinctly recreative or amusing? He has, too, his moments of weakness, his hours of doubt, when he is oppressed by the feebleness of his efforts, the apparent uselessness of all his endeavour and the emptiness of his outlook. Is there sufficient purpose in what mathematicians have achieved to provide him solace at these times? Has the use of Mathematics been so beneficial in the interests of humanity as to strengthen him in the continuation of his task? It is then that his mind becomes receptive of a higher conception of his subject. In contemplating its strength and greatness, its permanence and beauty, he recognises that it has defined his attitude to the world and has guided him in the art of living.

This, then, is the first consideration: Is Mathematics interesting or not?—one not unimportant in the view of the modern trend of educational method. Can the subject be made attractive not merely to those who have the natural aptitude, but also to that greater number who apparently use it as a means towards an end? The justification of the introduction of any element that will have the tendency to drive away monotony is apparent when we consider how progress is dependent on the awakening and the maintaining of interest.

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[1] Bertrand Russell, *Mathematics and Metaphysics*.

It is naturally impossible for me to attempt a detailed exposition of the recreative aspect of mathematical work; and so I must be content to give a brief survey of the subject from this point of view, to make a short reference to one or two of the suggestions that will have been made, and to make one theme the chief illustration. Mathematics is particularly fortunate in possessing a wide field from which to select work of this description, the following being some of the possibilities: Recreations, Arithmetical, Geometrical, and Mechanical; Practical Mathematics; its uses in such spheres as business, sport, or war; its applications to other sciences; its history, not only of individuals, but of the problems that have been handed down from the past; and, lastly, a more recondite subject, hardly suitable for the immature—I mean the study of its fundamental notions, a study that is necessary for obtaining a true conception of its ideals and infinite possibilities.

There are three facts in the modern history of Mathematics that show a tendency in the direction of which I am speaking—a tendency towards the lightening of the burden of the mathematical pupil. The first is the use of Analytical methods, which became universal in England about ninety years ago; the other two, of comparatively recent date, are the superseding of Euclid and the introduction of Practical Mathematics. The treatment that has replaced Euclid is open to innumerable objections, but it still remains a step in the right direction, and was taken on the Continent long before we thought about it. The deadening influence on the youthful mind of abstract methods of exposition is further mitigated by the introduction of Practical Mathematics; and it is therefore not unreasonable to suppose that this subject, which is in its infancy, will in future include sections not hitherto contemplated.

This naturally leads us on to think of the interesting story of the applications of Mathematics to other sciences and to the ordinary business of life. Much of it is known, at least vaguely, to most people, and it is unnecessary here to illustrate what is common knowledge. It is difficult, however, to think of the subject at all without at least referring to the remarkable work of that illustrious mathematician and physicist, James Clerk Maxwell. But rather than give positive instances of the extensive use of mathematical results, I venture to describe an incident from the late war to show the kind of situation that arises when the application of a mathematical idea is entrusted to the uninitiated. In the schools of instruction established for officers, many of the classes were, as is well known, conducted by sergeants of the regular army. These instructors were efficient in many ways, but it would be an exaggeration to say that their knowledge of science was profound. One of them I know of was explaining to a class of Artillery officers how the angle of elevation of a gun was measured, and in the course of his argument made the statement that the diameter of a circle went exactly three times into the circumference. One of his audience was dubious of this, and asked him if that was quite accurate. "Was there not a little bit left over when the division was made?" This made the instructor shaky of his position, and he said he would get the sergeant-major to explain. This particular sergeant-major had the reputation of being omniscient; and, in any case, being a sergeant-major, was never at loss for a reply. He came over to the class and said he would explain how it was that the diameter went into the circumference exactly three times. Taking a penny from his pocket and holding it up, he said, "Look at the little circle formed by this penny. If you were to measure the diameter and then the circumference, you would find that the one was three times the other." "But, of course," he added disdainfully, making a large sweeping movement with his hands, "if you had a *big* circle, anything might happen."

Some people are above Mathematical recreations, but when we remember that in most of us there is something imaginative, something of the spirit of emulation, we can afford to ignore their views. Some would say that recreations are too trivial to deserve serious thought, but what has been the study of men like Euler, Fermat, and Legendre, we cannot affect to despise. Liebnitz in one of his letters remarked[1] that men were never more ingenious than in the invention of games; here the mind was at ease; after games that depended solely on numbers came those of position; and after those, where only number and position appeared, came the games that involved motion; that one would, in fact, desire to have a course of study, entirely devoted to games treated mathematically.

A typical arithmetical fallacy is one dependent on the ambiguity of the root sign. For example, we may express the identity

$$\sqrt{-1} = \sqrt{-1}$$

in the form $\sqrt{\frac{1}{-1}} = \sqrt{\frac{-1}{1}}$

and therefore $\frac{\sqrt{1}}{\sqrt{-1}} = \frac{\sqrt{-1}}{\sqrt{1}}$

hence $(\sqrt{-1})^2 = (\sqrt{1})^2$ on multiplying across

$$\therefore -1 = 1.$$

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[1] Quoted by W. W. Rouse Ball in *Mathematical Recreations*, 1919. (Macmillan, 12*s*. 6*d*.)

There is an excellent problem, neither a catch nor a fallacy, but really perfectly straightforward, which a reader may successfully try on his friends—if they have not heard of it previously. It illustrates the well-known fact that an arithmetical problem is frequently not just what one may hastily suppose. The problem is this:

A man is engaged at a salary which commences at the rate of (say) £400 per annum, and is asked which he will prefer, a yearly rise of £40 or a half-yearly rise not of £20, but of £10. Which should he select?

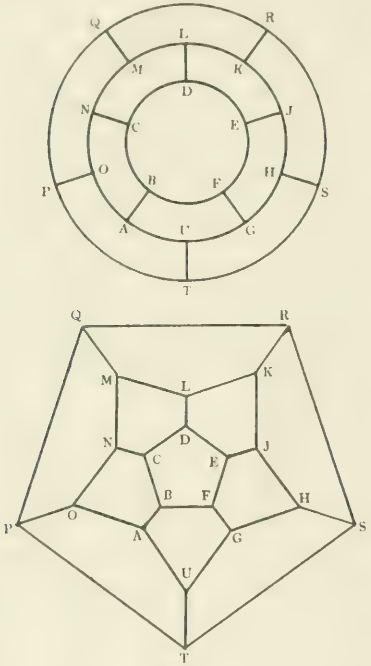

Fig. 1.

Most people will say at once, the former; but they are wrong. For with the first choice the man would receive £400 in the first year, and with the second choice £200 + £210. He has thus £10 more at the end of his first year. During the second year his first choice would give him £440, his second choice £220 + £230. Again he has £10 more, and this continues each year.

Geometrical recreations consist chiefly of fallacies, paradoxes, and games of position, and it will be sufficient for me to illustrate them by taking a typical example of the latter known as the Hamiltonian Game.[1]

This game was invented by Sir William Hamilton, and consists in the determination of a route along the edges of a regular dodecahedron which will pass once and once only through every angular point. As a dodecahedron is a solid figure, it is consequently difficult to use for this game, and for the purposes of solution the solid may be conveniently represented by either of the diagrams of Fig. 1.

To make the problem really a game, Hamilton gave each point lettered in the diagram the name of a town, so that the game consists in starting at any town and going "all round the world," visiting every town once only, and ending up at the point of departure. The game is varied by compelling the solver to visit certain towns in a certain order first before going on to the others. Not more than five towns should be included in this restriction.

The problem is attacked in the following way: At each angular point there are three edges (three lines in the diagram). As we approach a point there are only two routes open to us after passing it—the one leading to the right is denoted by r, that to the left by l. If we go to the left; then, after passing a town, to the right; then, after passing a second town, to the left, we denote the operation by lrl; twice to the left and once to the right by l^2r, and so on. Five times in succession to the left, or to the right brings us back to where we started. These facts may be represented by the equations $l^5 = 1$, $r^5 = 1$. It will also be found from the figure that the following pairs of journeys lead to the same place: lr^2l and rlr; rl^2r and lrl; lr^3l and r^2; rl^3r and l^2.

Now, in our problem we have to move through twenty points, ending up where we began. There are thus twenty successive operations, the total effect of which is equal to unity. We have, therefore, to find an expression which has twenty terms in r and l which will be equal to unity. This expression is obtained thus: By making repeated use of the relation $l^2 = rl^3r$ we find that

$$\begin{aligned} 1 &= l^5 = l^2 l^3 = rl^3r\, l^3 = (rl^3)^2 = \{r(rl^3r)l\}^2 \\ &= \{r^2\, l^3\, rl\}^2 = \{r^2\, rl^3r\, lrl\}^2 = \{r^3\, l^3\, rlrl\}^2 \end{aligned}$$

$$\therefore \{r^3\, l^3\, (rl)^2\}^2 = 1.$$

$$\text{Similarly } \{l^3\, r^3\, (lr)^2\}^2 = 1.$$

Each of these has twenty terms.

Hence to go "all round the world" our directions are:

r r r l l l r l r l r r r l l l r l r l,

or

l l l r r r l r l r l l l r r r l r l r.

The first set of directions means "go to the right till the next town is reached, then go again to the right till the next town is reached, then again to the right, then to the left, to the left again, etc.," and similarly for the second.

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[1] W. W. Rouse Ball in *Mathematical Recreations*, 1910, p. 189.

It should be pointed out that one may commence at any point in the series of operations by transferring the proper number of letters from one end to the other. Thus, suppose we choose to commence with the ninth direction of the first series, the new series of directions would be:

r l r r r l l l r l r l r r r l l l r l,

or if we commenced with (say) the eighth of the second series, the new series would run:

r l r l l l r r r l r l r l l l r r r l.

The particular direction we commence off with is fixed by the order of certain towns which we must visit initially.

Suppose, for example, we are told to start at S (see the figure), proceed to H, then to J, then to E, then to D, and then to go once through all the other towns, and return to S. From S to H is either *l* or *r* depending upon whether we got to S from T or R. From H to J is *r*, J to E is *l*, E to D is *r*. Our directions initially are, therefore, either *lrlr* or *rrlr*. The first of these combinations occurs in the First Series and the second in the Second. The solutions are, therefore,

l r l r r r l l l r l r l r r r l l l r

and

r r l r l r l l l r r r l r l r l l l r,

and the orders of the towns visited are respectively

S, H, J, E, D, L, K, R, Q, M, N, C, B, F, G, U,
A, O, P, T, S

and

S, H, J, E, D, C, N, O, A, B, F, G, U, T, P, Q,
M, L, K, R, S.

Mr. Rouse Ball, who describes this game in detail, recommends the solver, for convenience and to prevent error, to make a mark at, or put down a counter on, each town as it is reached.

A geometrical problem of a simpler and better-known kind is the "proof" by dissection that 65 = 64. If the square of side 8 in Fig. 2 be cut along the lines indicated, it may be fitted into a parallelogram whose sides are 13 and 5.

The paradox depends upon the relation

$$5 \times 13 - 8^2 = 1$$

and the fallacy lies in the fact that the four pieces of the cut-up square, when fitted together, do not really make a parallelogram. There is a small diamond-shaped space, the area of which is 1, which is apt to be overlooked unless the cutting-up and the fitting together be very accurately carried out.

A square of side 21 may be similarly cut up and fitted together to form a parallelogram of sides 13 and 34; and one of side 55 to form a parallelogram of sides 34 and 89.

The subject of Arithmetical recreations forms part of a section of mathematical work which is sometimes regarded as special in character, but whose results permeate the whole of Mathematical study. The Theory of Number is full of paradox and mystery, treating of entities apparently simple in character, but really so complex as to provoke everlasting discussion. Number is the root of all mathematical evil; it is the source of much mathematical pleasure. The study of its true significance has traditionally belonged to abstract philosophy, but now the mathematician can give the more adequate interpretation. The processes of counting and tallying are amongst the first activities of human intelligence; and the problems that arise in connection therewith form the subject-matter of the most recent mathematical research. Its domain is vast. A true conception of its nature is fundamental to analysis, and the modern theory corresponds in a remarkable way to the traditional and empirical notions of spatial magnitude.

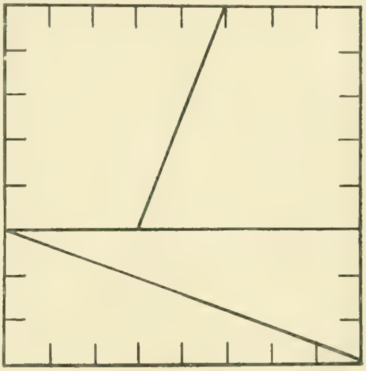

FIG. 2.

Positive numbers present themselves in a dense array stretching from the infinite to the infinitesimal. Imagine them arrayed in order of magnitude as we do when we represent them by points on a line. They are so dense that an infinity of them exists between any two of them, however near. But of this vast aggregate certain numbers stand out with great prominence, possessing properties of a special and often mysterious nature. They are human in some of their attributes, for some are perfect and some are amicable; some lucky and some unlucky. One investigator who spent the greater part of his life in studying them became so familiar with them that he was said to regard each positive integer as a personal friend.[1] Although this class of positive integers forms the subject-matter of a theory by itself, the interesting fact in connection with them is that the solution of many of its classical problems is intimately associated with the theory of functions of continuous magnitude. One feature that distinguishes it from most of the other branches of Mathematics is the comparative simplicity with which its problems can be stated; not merely the easier problems, but even those that have hitherto defied solution. For example: What is the minimum number of squares which, when added together, will equal any given number? What is the number of primes less than n? Goldbach's Theorem that every even number is the sum of two primes. Waring's general problem and the theory of Mersenne's numbers; and the famous last theorem of Fermat that $x^n + y^n = z^n$ has no solution in positive integers if n is greater than 2.

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[1] Prof. G. H. Hardy, *Some Famous Problems of the Theory of Numbers*, 1920.

More detailed mention may be made of one of these.[1] In 1644 Mersenne published a book in which he asserted that, in order that $2^p - 1$ may be a prime number, the only values of p, not greater than 257, which are possible are 1, 2, 3, 5, 7, 13, 17, 19, 31, 67, 127, and 257; 61 has since been added to this list. To confirm Mersenne's statement is an extremely laborious undertaking, and it has been tested in a few cases only, but so far as we know at present the statement is true. The number $2^{61} - 1$ is the highest prime number at present known. Evaluated it is 2,305,843,009,213,693,951. The expression $2^{p-1}(2^p - 1)$ where $2^p - 1$ is a prime number is considered to include all perfect numbers. A number is said to be perfect if it is equal to the sum of all its integral subdivisors. 28, for example, is a perfect number because its divisors 1, 2, 4, 7, and 14, add up to 28, so is 6, so is 496. It is considered that *every* perfect number must be expressible in the form given above, because the expression has been shown by Euler to include all *even* perfect numbers, and it is believed that an *odd* number cannot be perfect.

Now, the prime numbers represented by the expression $2^p - 1$ are known from Mersenne's work. Thus, if $p = 2$, the corresponding prime number is $2^2 - 1$, i.e. 3, and the corresponding perfect number is $2^{2-1}(2^2 - 1)$, i.e. 4. If $p = 3$, the corresponding prime number is similarly 7, and the corresponding perfect number is 28. If $p = 5$, the prime number is 31, the perfect number 496. If $p = 7$, the prime number is 127, and the perfect number 8,128. As the values of p increase, the prime and perfect numbers increase alarmingly. Thus, if $p = 61$, the prime number corresponding is 2,147,483,647, and the perfect number 2,305,843,008,139,952,128. It would be rather a long and difficult task to factorise this last number and show that the sum of the factors is equal to itself!

This simplicity in subject-matter makes it a fruitful field for mathematical recreation. The problems are numerous, and many of them may be found in the well-known work of Mr. W. W. Rouse Ball. The questions that arise may be trivial or important; they may make problems of a day or problems for all time. There is a game which may sometimes be seen played for high stakes in the smoke-room of an Atlantic liner, and which may serve as an illustration of the former type. It has the appearance of being solely dependent on the chance arrangements of the numbers concerned, but in reality an expert can nearly always beat an unskilful opponent. The contents of a box of matches are divided at random into three heaps. The rule of the game is that the one whose turn it is to play may take *one* or *all* from any heap, but he must not touch more than one heap. The loser is the one who is forced to take the last match. If, for example, after several moves, a player leaves his opponent 1 : 1 : 1, he must win, for his opponent is forced to take the last match. Again, if he leaves 1 : 2 : 3, it is not difficult to see that he can also force a win. The method of the expert is to remember certain key-numbers which will force a win from the initial outlay. The solution of the problem of finding these key-numbers has been given in an American journal,[1] and is very ingenious. It consists in expressing the numbers in each heap in the binary scale. (On the binary scale, 1 is represented by 1, 2 by 10, 3 by 11, 4 by 100, 5 by 101, 6 by 110, 7 by 111, 8 by 1,000, 9 by 1,001, 10 by 1,010, 11 by 1,011, 12 by 1,100, 13 by 1,101, 14 by 1,110, 15 by 1,111, 16 by 10,000, and so on. See *Scales of Notation* in an Arithmetic Book.) If the sums of the corresponding digits are *all* even, the outlay forms a key-number. By corresponding digits are meant all the digits at the right of the numbers, or all those second from the right; or all those third from the right, and so on. If some are odd, it can be so altered according to the rules to form the required combination. For example, if the initial outlay were 8 : 7 : 9, these numbers in the binary scale are 1,000 : 111 : 1,001. The sums of the corresponding digits are 2, 1, 1, 2. It is, therefore, not a key-number, but can be made one by removing the two 1's, i.e. by changing the middle heap to 1. A little experience both in the theory of this problem and in its practice will make one an expert in it.

The above example illustrates the recreative aspect of number, but gives no indication of the vast number of ingenious problems and games of skill that have been devised. The more serious types of problems may not always be justly termed recreative, but they certainly can be described as interesting. They are characterised by their age and historical connections, by the simplicity of their statements and by their intractability. This is sufficient to command the attention and interest of even the immature, and it would not be ridiculous to imagine a schoolboy making a praiseworthy attempt at the solution of Fermat's last theorem. There is probably no other branch of scientific work where such a remark would apply. The fact that a great deal of recent mathematical research has been concentrated in this direction is an item of additional interest. Progress is being made in two main classes of problems —in the theory of partitions and in the theory of the distribution of primes. In both of these is seen the same fundamental characteristic—the intense difficulty of the analysis combined with the remarkable simplicity of the results aimed at. It is comparatively simple to enunciate the problem: In how many ways is it possible to express a number n as the sum of other numbers less than n?—but its solution requires the discussion of an elliptic modular function. It is suggested, then, not that the methods here are simple, but that the results achieved and contemplated are in many cases within the comprehension of those of moderate attainments.

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[1] This is taken from Mr. Rouse Ball's book.

[2] W. W. Rouse Ball, *Mathematical Recreations*, p. 21.

The positive integers, however, form only a very small class of the numbers that exist. The theory of rational and irrational numbers brings problems to our notice of a totally different character. It is here that the mathematician has entered the realm of the philosopher, and has seized territory from which it will be difficult to dislodge him. The problems of the infinite and the infinitesimal have been inadequately represented since Zeno first propounded them in his famous paradoxes. The great Eleatic, unconscious of the false premises latent in his mind, obtained results inconsistent with experience. A strict investigation into the nature of the mathematical infinite, effectively conpleted by the mathematician, is necessary for the solution of the paradoxes. The fallacy is now seen to consist in applying the properties of finite aggregates to the infinite. That the whole is greater than its part, or that a number can be obtained by the process of counting, seem self-evident statements, but they produce disastrous results when applied to the infinite. The accurate theory of the irrational and of the infinite, first propounded by Dedekind and Cantor about fifty years ago, gives rise to many interesting speculations. What, for example, is the correspondence between a set of points and the continuum of real number? Are all infinite numbers equal? Is there a greatest number? It seems natural to suppose that there must be, namely the number that includes everything, but Cantor proves that it does not exist.

From such speculations the mind naturally passes to the consideration of the general philosophy of Mathematical thought: its purpose and ideals. Its value in a technical education will be revealed by its usefulness, but its ideals alone measure its value in a liberal education. The Professor of Mathematics at Oxford said quite recently that the life of a mathematician was possibly one which no perfectly reasonable man would elect to live, and that "it is something to be able to say that at any rate we do no harm."[1] There is a chance of such a remark being taken more seriously than was intended, for there is a tendency for the mathematician to concede all that is artistic to the classical and literary scholar. He is apt to think that its manifold uses in the practical life are sufficient to compensate what many regard as its deficiency in culture. But there must be value in a study that tends to regulate the mind in its outlook on life—one freed from those natural prejudices and desires that prevent a clear, uncoloured view of human conduct. The scientific method, as the Hon. Bertrand Russell has persuasively shown,[2] is free from the disturbing influence of ethical considerations, and might be oftener used in other branches of thought. There have been instances even in the history of science itself where progress has been hindered by the introduction of ethical and religious beliefs. To believe that the earth went round the sun was to show the greatest irreverence, this being inconsistent with the theory, so comforting to human egoism, that the earth was the centre of the universe. The classicist and literary scholar, we are often told, lives in the past, and when contemplating the things of the present, will exclaim in the words of the Ecclesiast, "There is nothing new under the sun." Talk to him of some event in modern history, and he will give you a quotation from the austere historian of Greece, describing an exact parallel in the Peloponnesian War. However that may be, the mathematician is not so encompassed by the presence of a completed system of knowledge, and consequently his endeavours are not obvious repetitions of what has already been done. It may be that the Chinese once knew of Taylor's theorem, or that the chimpanzee was once acquainted with the rule of three, but we certainly do not know these statements to be true; and we think them highly improbable. There is always, therefore, the hope of discovery of something new, and comfort in thinking of possible achievement.

In the modern striving after practical results, there is an aspect of Mathematics that is apt to be ignored. The high value with which we estimate a technical education should not detract from the æsthetic claim of Pure Mathematics based on the beauty of its pure reasoning. It is not a beauty of colour and shade; it is one of order and austerity. There is nothing incongruous in regarding as a work of art a theorem wherein is displayed a simple exposition of the necessary and sufficient.

This suggests another characteristic often absent elsewhere—the characteristic of permanence; and it can be no mean occupation to be an artificer in an edifice the foundation-stones of which were laid before Pythagoras lived. Here there is work for the mediocre as well as the talented; as Russell puts it: "The edifice of science needs its masons, bricklayers, and common labourers as well as its foremen, master-builders, and architects. In art nothing worth doing can be done without genius; in science even a moderate capacity can contribute to a supreme achievement."[1]

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[1] *Some Famous Problems of the Theory of Numbers*, 1920.

[2] *Scientific Method in Philosophy*.

The reader may study the subject further in *Mathematical Recreations and Problems*, by W. W. Rouse Ball. Eighth edition. (Macmillan, 12*s*. 6*d*.) A fascinating book.

The Rôle of Physiology[2] in National Life

By A. V. Hill, Sc.D., F.R.S.

Professor of Physiology in the University of Manchester

HITHERTO Physiology has had two rôles, that of an abstract science devoted to the elucidation of problems provided by the living creature, and that of the handmaid of medicine attempting to describe the normal healthy functions which medicine has to restore after they have gone wrong. The physiologist, therefore, had to earn a living either as a student and teacher in a university, or as a practising medical man. To these two rôles is now being added a third, which we will proceed to describe—that of a student and investigator of the human or biological factor in the social, economic, or industrial system.

It is obvious that in the last resort our political and social system rests upon the mental and bodily characteristics of its unit, MAN, and that these in the aggregate depend largely on heredity and environment, and not merely on fortuitous factors. The exact degree to which the behaviour and the bodily, mental, and moral "fitness" of men depend upon environment and heredity is not yet known, possibly not knowable: it is certain, however, that, within limits, "fitness" and efficiency depend upon adequate training and nutrition, and mental, moral, and bodily health on heredity and example as well as on environment. Further, it is obvious that a man's natural powers fit him usually more for one trade than another, and that it ought to be possible often to state in precise terms what that trade should be. Hitherto selection, both in national and in individual life, has been left to nature, and man has progressed slowly and unconsciously towards an unknown goal. Recently, however, he has taken upon himself so largely to control, by understanding, the forces of nature, that a whole new crop of problems is springing up insistently around him. Large urban populations have arisen as a result of the conquests of hygiene and engineering; plagues have been abolished by the discoveries of medicine; famines have been mitigated by facility of transport, and highly skilled and specialised trades have arisen calling for a new type of average man. Moreover, the coming of some degree of general education and self-government, together with the growth of class consciousness and nationalism, have made it necessary to exercise the utmost care in the applications of the science of man as a biological unit. These applications, however, are bound to come: man has taken upon himself to prevent plagues and to mitigate famines, and he will shortly have to limit population, to improve industrial efficiency and to eliminate waste—or a worse thing will befall him. All men get sick and die, and so all pass within the purview of medicine: this is inevitable, and there is little prejudice against regarding the sick man as the "material" of medical science. But many men, for the larger part of their lives, are normal healthy individuals; many others would have been healthy had we made an adequate study of the conditions required to maintain their efficiency in the state of life to which they have been called. These men require, not medicine, but physiology, to discover, develop and utilise their normal powers and functions to the full, and to see that the lives they lead are of the greatest benefit to themselves, to their neighbours, and to their descendants.

Nutrition, hours of work, standards of physical and mental fitness of different types of population, recreations, physical training, vocational training, standards of living, the effect of various habits and propensities on the normal man, eugenics and what to breed for if we could, these are among the many points at which the economic and social problem touches on the biological one. Physiology as yet can give no answer to these problems, partly because of their inherent difficulty, but largely because she has tended, with Medicine, to regard the human factor from the bedside. It is necessary to found a new profession, that of Physiology, charged with the study of the biological factor in normal human affairs.

To take an example from the more purely physiological side, the investigations of J. S. Haldane on the respiratory conditions in mines, the experiments by Hopkins on "accessory factors" in food, or the work of the Anthropometric Standards Committee of the Medical Research Council, are examples of the way in which biology may come in immediate contact with national life: while in the domain of psychology "motion study," scientific management, mental tests for aviators, and vocational training, are among the applications on which the younger science is beginning to test its new-found freedom.

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[1] *Science and Culture.*

[2] To avoid a cumbrous form of expression "Physiology" is used here to denote the study of all the normal processes of the animal, including those usually described as psychological.

How is the Profession, as distinguished from the Science of Physiology, to find its place in our social system? Medicine is maintained by the urgent need felt by the sufferer for relief and help: the normal man equally may need advice and help, but he has not the same potent realisation of his need. It is necessary to call in motives more far-seeing than pain or fear to establish its existence. Such a motive may be found in the educated self-interest of a great industrial concern, which has appreciated the value of an impartial and critical investigation of the human factor in its success: or it may be found in the foresight of government or municipal bodies, or in the generosity of private benefactors, who have realised that the scientific study of normal man in relation to his inheritance and his environment is an essential stone in a rational structure for society. But in whatever way the profession can be created, it has no lack of opportunity for fruitful service.

The most urgent need for physiology is discovery—a more extensive knowledge of the physical, chemical, biological, and psychological factors governing the living creature. Such work can best be done at universities, with the intellectual stimulus of university life. Progress is within sight in all directions if only workers, equipment, funds, and leisure can be made available. But accompanying this discovery there is required, scarcely less insistently, an interpretation of its meaning in terms of human life and this interpretation can be made only if there be a sufficient body of "professional" interpreters, men well trained, at least as well trained as the Medical Profession, in the elements of scientific thought, and given the duty of applying physiological methods and results to industrial, economic, and social problems. Society is built for man, not man for society: and an impartial scientific study of man in relation to the structure of society is a first condition if the structure is to survive the struggles and aspirations of its occupant.

BOOKS RECOMMENDED

General Practice and X-rays. By (MRS.) A. VANCE KNOX, M.B., and ROBERT KNOX, M.D., C.M. (A. & C. Black, 15s.)

A handbook for the General Practitioner and Student. Dr. Knox is well known as an authority on Radiography and Radio-therapeutics.

Principles of Human Geography. By ELLSWORTH HUNTINGTON and SUMNER W. CUSHING. (New York, John Wiley; London, Chapman & Hall, 21s.)

Sir James Young Simpson

JUNE 7, 1811 MAY 6, 1870

The Discoverer of the Anæsthetic Properties of Chloroform

By Edward Cahen, F.I.C., A.R.C.Sc.

ALTHOUGH Sir James Simpson's name will always be connected with the discovery of the anæsthetic properties of chloroform, he owed his fame really to his own personality, his great ability, and the reforms he introduced into the practice of medicine and surgery. These reforms were carried through by his indomitable will and fighting spirit. It is certain that, even if he had not discovered the power of chloroform to induce anæsthesia, he would nevertheless have reached the pinnacle of fame through his fight for anæsthetics, and because of his work as an obstetrician. It is of interest to note that such was his final victory for chloroform, that ether, the anæsthetic properties of which had been discovered earlier, was for many a long year banished from general use by the profession, and it is only in recent years that this substance has come again into general use.

Simpson was of humble Scottish birth; his father was the local baker in the small village of Bathgate, in Linlithgowshire, and the boy had to take his share in the business with his brothers. He was, however, early singled out as the son for whom special sacrifices were to be made in order that he might bring honour on his family. Apart from the help he thus received, which enabled him to receive an education which should fit him for his future, he owed his rise to fame entirely to his own ability and ambition. His one thought was to repay his people for what they had done for him. At the tender age of fourteen he left the parish school and went straight to the University at Edinburgh. His early upbringing had been in an exceedingly narrow atmosphere, but this did not prevent the lad from entering on his studies with that keen delight in the search after the truth, which was in such contrast to his early surroundings, and which always actuated him throughout his life. In 1830, at the age of but eighteen, he found himself a qualified practitioner, and two years later he graduated as Doctor at the University of Edinburgh, being one of the last candidates to undergo the ordeal of an examination conducted in Latin. His thesis so impressed his examiner, Thomson, the Professor of Pathology in the University, that he offered him the post as his assistant at £50 per annum. This the poor lad eagerly accepted as a means of relieving his family of the burden of keeping him, and he pursued his studies in pathology and midwifery.

Before settling down to a more remunerative occupatient Simpson determined to enlarge his experience by a visit to the chief seats of medical learning in Europe, and for this purpose he paid visits to Paris, Brussels, and Liège, taking London and Oxford on the way. On his return, in November 1835, he was elected President of the Royal Medical Society in Edinburgh, and chose a subject for his address connected with obstetrics. He next accepted the post of house-surgeon in the Lying-in Hospital, and at the same time, owing to Professor Thomson's ill-health, gave the lectures on Pathology at the University. In 1837 he obtained the post of Extra-academic Lecturer on Midwifery, and two years later, on the retirement of the Professor of Obstetrics in the University, this ambitious youth of twenty-eight applied for the vacant chair. After a great fight and the expenditure of much more money on canvassing than he could afford, he was elected by one vote by the Town Council in whose gift the chair lay. He even became engaged to Miss Grindley, of Liverpool, and married her during this anxious period of trial, for he thought that his youth and single state might prejudice his chances of election. On the evening of the day of his success he wrote to his father-in-law: "I was this day elected Professor. My opponent had sixteen and I had seventeen votes. All the political influence of both the leading Whigs and Tories here was employed against me; but never mind, I have got the chair in despite of them, Professors and all. Jessie's honeymoon and mine is to commence to-morrow."

SIR JAMES YOUNG SIMPSON.

From that time forth his reputation as a lecturer and an authority on the diseases of women increased, and his means became more affluent, so that he was able gratefully to pay off his debts to his father-in-law and his own family.

In his student days, the horrors of the operating-table were such as to defy description and exaggeration. On a sensitive youth such as Simpson, it was but natural that such a condition of things should have evolved feelings of disgust and a strong desire to alleviate the terrible sufferings, mental and physical, which the patients of those days had to bear when they were being operated on. With his customary industry and care, Simpson made a search through the records of antiquity to see what had been used in the past to induce insensibility. Indian hemp, he found, had been used under various names throughout the East for this purpose. Mandrake was another well-known drug (it was mentioned by Shakespeare) possessing narcotic properties. Methods of another kind had been tried, such as hypnotism; operations had actually been performed on hypnotised persons as recently as 1837. In 1800 Sir Humphrey Davy had discovered that laughing gas, an oxide of nitrogen, could produce a pleasant sensation of intoxication, and suggested its suitability for use in minor operations. Some thirty years later Faraday discovered that if ether were inhaled it had very much the same effect, but it was left to the Americans, Wells and Morton, to induce complete anæsthesia, and adapt the earlier experiments to practical ends. Wells was the first to have a tooth extracted under the influence of laughing gas (1844), and two years later Morton, who had not been so successful with laughing gas, found that ether would much more easily produce the same effect. He actually anæsthetised himself by inhaling this substance on his handkerchief.

Early in 1847, the year in which he was appointed Physician Accoucheur to Queen Victoria in Scotland, Simpson, still a young man, began to use ether systematically in his large obstetric practice, thus gaining for the Edinburgh Medical School the honour of being the first place where use was made of the new means of alleviating suffering. He was not, however, entirely satisfied that the best substance had been discovered for this purpose, and he set about searching for the ideal drug that would produce the effects that had already been produced by ether and laughing gas. This work was done in the evenings at his house in Queen Street, a house which had already attained fame as the resort of anyone of importance who happened to be visiting Edinburgh. Here, assisted by his devoted disciples, he began to try all sorts of liquids on himself and his assistants in the hope of discovering the ideal. A certain Mr. Waldie, a Liverpool chemist, who originally came from Simpson's own county, suggested chloroform as a likely liquid for the purpose. Simpson had already had some chloroform, but had set it aside as being heavy and unpromising for the purpose. The bottle containing the heavy oily liquid was accordingly fished out again from numbers of others and its contents sampled. It was on the 4th of November 1847 that the discovery was made that this unpromising, sweet-smelling liquid would do all that was required of it and do it extremely well. Chloroform had been discovered by Liebig in 1831, and independently by Soubeiran in the same year.

Now began the usual battle that we have already witnessed in the case of Pasteur [1] and Lister,[2] a battle against ignorance, prejudice, and professional jealousy. Simpson, unlike Pasteur, who was worried by his opponents, entered the contest with the keenest delight, and wrote long dissertations, often in a humorous vein, to confound his enemies, making them appear ridiculous in the eyes of the world.

His greatest delight was to fight them with their own weapons; thus he met those who objected on religious grounds by quoting Genesis ii. 21, " And the Lord God caused a deep sleep to fall upon Adam; and he slept, and He took one of his ribs and closed up the flesh instead thereof." By April 1853 the victory had been completely won, for then the Queen was anæsthetised with chloroform. The methods of administration of chloroform at Edinburgh were so excellent that they have remained unchanged to this day, and practically no other anæsthetic is used in that school. The discovery of anæsthesia, and more particularly the discovery of chloroform, caused a complete revolution in the field of surgery and obstetric practice, coming as it did almost simultaneously with Lister's great discovery of antisepsis. The two together rendered surgery not only comparatively safe, but also painless. The whole atmosphere of the operating theatre was completely changed from a scene of horror resembling a shambles, to the calm and peace that surrounds the surgeons of to-day in the orderly theatres of our great hospitals. Simpson narrowly escaped fame from an entirely different discovery of a means of stopping the bleeding of the severed arteries in major operations. Hitherto these had been tied with silk of doubtful cleanliness, which as often as not set up local blood-poisoning. Simpson devised a method known as " acupressure," which was, however, superseded by Lister's antiseptic soluble ligatures. Simpson's work on Hospitalism, long before Lister's discovery had brought about the revolution it did, had done much to improve the conditions in these institutions. He suggested rebuilding, cleansing, and segregation, and his plans would have done much to arrest the appalling mortality prevalent in the hospitals of those days, had Lister's antiseptic surgery not come in just as his efforts were about to bear fruit. Though Simpson had been tempted to desert Edinburgh for St. Bartholomew's Hospital in London, he remained faithful to the city of his choice until death. A grave in Westminster Abbey was offered, though the offer was declined by his family as he had himself chosen his last resting-place on the hills surrounding his beloved city.

NOTE.—*Sir James Young Simpson and Chloroform*, by H. Laing Gordon, in the *Masters of Medicine* (Fisher Unwin, 1897), is recommended for a short, concise account of this great physician's life.

The Psychology of Religious Experience

By Robert H. Thouless, M.A.

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WE do not give a sufficient account of religion by describing it simply as a particular mode of behaviour, or as a system of beliefs, or as a particular system of emotions. It is all of these things. It includes a peculiar kind of behaviour, of which worship is the principal part. It has a system of beliefs which are the necessary accompaniment of this behaviour; worship is impossible without a belief in a Being or beings to whom that worship is offered. It is, however, with the emotions accompanying religious behaviour that this article is concerned. These are usually given the name of " religious experience."

It is probable that all persons feel religious experience at some time in their lives, though it is only in the religious mystics that it plays a dominant part in the shaping of their conduct. The sense of peace after prayer or sacrament, or of exalted emotion after a stirring sermon, are examples of religious experience. Other examples may be found in the feeling of the presence of God as described by Brother Laurence in his book on *The Practice of the Presence of God*, or even in the vague feeling of an intimate presence in nature—such as that given by Thoreau in the chapter on Solitude of his *Walden*.

Certain religious practices have as their aim the intensification of the emotional experiences of religion. This is avowedly the object of the " contemplations " and " colloquys " of the Spiritual Exercises of

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[1] DISCOVERY, November 1920. [2] DISCOVERY, January 1921

St. Ignatius Loyola, and of the control of breathing and posture which is more developed in Eastern religions. A similar intensification or religious experience is also the result of practices in which this is not the conscious intention. Such are: fasting, the use of oratory in pulpits, of solemn music and ritual, of lighted candles, and of a monotonous voice in the reading of the religious service.

It must be the task of the student of the psychology of religion to explain the facts of religious experience in terms of the same psychological theories as are used to explain the facts of our ordinary mental life. A religious psychology which explains every new action of the mind by the creation of a new faculty, which, for example, explains our sense of the presence of God by speaking of a "transcendental consciousness," is really abandoning the task of giving a scientific account of religious psychology altogether. We may, of course, find that it is impossible to give an account of the mental phenomena of the religious life in terms of our ordinary psychology, but the method just described would still be open to criticism. It professes to have given an explanation when it has, in fact, merely repeated the facts which it was trying to explain.

We must notice at the same time that our hope of finding it explicable in terms of the ordinary operations of our minds is not a hope that religious experience may prove illusory. In the physical world we see the finger of God in events which take place in accordance with law, and there seems to be no reason for taking a different attitude towards mental events. Conversion may take place in accordance with laws as fixed and definite as those obeyed by the lightning flash (though it is unlikely that we shall ever be able to demonstrate that it does), but this would be no reason for denying the truth of the religious explanation of it.

Discovery in the psychology of religion is therefore very largely the application to religion of discoveries made in secular psychology. In such advances the history of psychology during the last thirty years has been rich. The attention of psychologists has turned away from the problems of the old analytic introspective psychology, which was principally occupied with questions connected with cognition and perception. It is now much more concerned with questions of greater human interest, with the driving forces behind human conduct—instincts and emotions. The older psychology was of great importance for the philosophy of religion, since it discussed the problems of knowledge; the newer psychology is of equal interest to the psychology of religion, since it discusses the mental roots of man's behaviour, including his religious behaviour.

The discoveries in psychology whose connection with religious experience I wish particularly to point out in this article are those made by Freud and his followers. It may be objected that it seems perilous to found any conclusions on a system of theories which is itself being hotly contested by psychologists. At the same time, we must recognise that, however much psychologists may differ from Freud and his school in matters of detail, there are broad general principles revealed by his work which can never be overthrown because they are founded on the firm basis of observed fact. The discussion in this article will be limited to such firmly grounded principles.

The first of these is the fact that a large number of our thoughts and actions have their causes in mental processes which are unconscious. By an unconscious mental process is meant one which we are not aware of, and of which we cannot make ourselves aware by any redirection of our attention. Thus, if a clock is ticking in a room in which we are working, and though we are not aware of its sound, we can immediately become aware of it by listening to it, the hearing of the noise would not be an unconscious mental process in the sense in which the word is used by Freud. Examples of true unconscious mental processes may be found in an article on "Mistakes" in the DISCOVERY of last April. The wishes which express themselves in dreams and in certain mistakes in speech or writing are unconscious in this sense. Experiences painful in themselves—as, for example, some of the horrible experiences of the war—or wishes which become painful because of the impossibility of their fulfilment, are banished from the mind by an unconscious process called "repression." They are no longer present to consciousness, but can still exert an influence on the behaviour and emotional dispositions of the person possessing them. In certain cases they lead to forms of insanity.

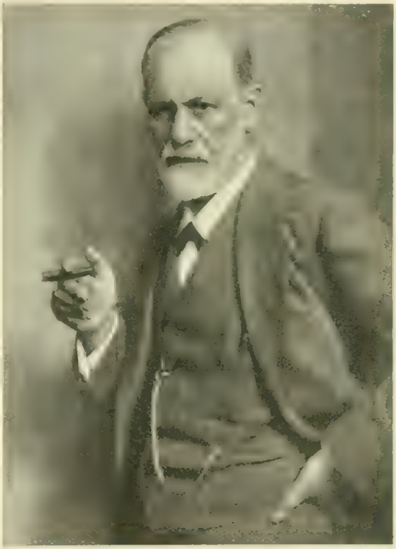
We will take a typical case of religious conversion, and see how far the process of repression can help us to understand the mental processes which precede it. The story which follows is of the conversion of M. Ratisbonne which is given in *The Varieties of Religious Experience*, by W. James.

M. Ratisbonne was a Jew who became converted to Catholicism. He was irreligious, and had an antipathy to priests. In his twenty-ninth year a French gentleman tried to make a proselyte of him, but M. Ratisbonne did not take his efforts seriously, his own part in the conversations being of a light and chaffing order. But the words of a prayer to the Virgin he promised to read haunted his mind for several days, and the night before the crisis he had a sort of nightmare in which he saw a black cross with no Christ on it. Until noon the next day, however, he was free in mind, and spent the time in trivial conversations. By chance on that day he met his friend, who asked him to wait for a few minutes while he went inside a church. M. Ratisbonne entered the church himself to look at it while he was waiting. Suddenly he passed through an experience he was unable afterwards to describe, in which he saw a vision of the Virgin. His friend found him prostrate on the ground, weeping. He felt the most ardent joy in the bottom of his soul. He asked for a priest. He felt that a bandage had fallen from his eyes, and he had acquired a knowledge and a faith of the truth, of which he could give no account.

This account shows the characteristic feature of suddenness which makes conversion such a striking mental event. Modern psychology explains such suddenness as due to the fact that the mental processes which resulted in the conversion were unconscious. We must suppose that, if we could have examined the unconscious mind of the convert before the event, we would have found that he had already begun to believe in Christianity, but that the change was repressed because of its conflict with the feelings and sympathies of his earlier life. The moment of the conversion was the moment when this repressed conviction became strong enough to overthrow the resistance to it, so that for the first time it became present to consciousness. Such unconscious processes, though they are banished from the conscious mind, can express themselves in dreams. The violently emotional dream which M. Ratisbonne had dreamed during the previous night shows that his unconscious mind was seriously occupied with the question of Christianity, although his conscious mind was not. His antipathy to priests may also be an indication of unconscious leanings towards Christianity. A violent and unreasonable prejudice against something is often a method by which the mind compensates for an unconscious attraction towards it. It is typical of the results of conversion that M. Ratisbonne felt that he had suddenly acquired a new knowledge, but was unable to give any account of the mental processes which led up to it. The psychologist explains this as the result of the fact that the mental processes leading up to it were unconscious, not that they were absent altogether.

A second fact which seems unmistakably to emerge from recent work in psychology is the very large part played in human activity by the love-instinct. That this is the case in religion is no new discovery of modern psychology. The fact that human and religious love are intimately related to one another has been guessed by many persons who have used their knowledge of this relationship either to depreciate religious enthusiasm or to exalt human love. The best example of the second of these two attitudes is probably Coventry Patmore. This is the theme of many of his poems. In one of his prose works he says: "There comes a time in the life of everyone who follows the Truth with full sincerity when God reveals to the *sensitive* Soul the fact that He and He alone can satisfy those longings, the satisfaction of which she has hitherto been tempted to seek elsewhere." In another passage he speaks of "that human love which is the precursor and explanation of and initiation into the divine." [1]

An American psychologist says: "Religion is at its best when its earthly image is most spotless and untarnished, and love is at its best where religion is purest and most undefiled. Just as this relationship seems to degrade religion only to those whose ideals or cults of love are low or undeveloped, so those who dispraise religion have not realised how indispensable it is to perfect love. How central this thought was to Jesus many parables and sayings attest. True piety is earthly love transcendentalized, and the saint is the lover purified, refined, and perfected." [2]



DR. S. FREUD, OF VIENNA.

The first indication of the intimate psychical connection between human love and the mystics' love of God is the frequency in their writings of language drawn from human love. Many of the mystics have found a congenial mode of self-expression in the Song of Solomon, which is purely a love song. Blosius prays in the following words: "O my beloved, my beloved, my beloved! O dearest of all friends, O my one love! O spouse of my soul, flower of love! Spouse of my soul, sweeter than honey in the honeycomb! Ah, sweetness, sweetness, sweetness of my heart, life of my soul! O calm light of my inmost soul! O Lord, my God! O most holy Trinity, one God, brighter than light, giving all delight, feed me, feed me; feed my soul with Thy inflowing grace."[1] Similarly Suso prayed: "Ah, my beloved! Thou art indeed an Easter Day of joy to me. Thou art the bliss of summer to my heart, and the hour of my delight. Thou art the loved One, whom alone my young heart loves and thinks upon, and for whom it has scorned all earthly love. Let this avail me now, my heart's beloved, and let me obtain a garland from Thee to-day. Ah, gentle heart! do this for Thy divine virtue's sake, and for Thy innate goodness, and let me not depart from Thee with empty hands this New Year's Day."[2]

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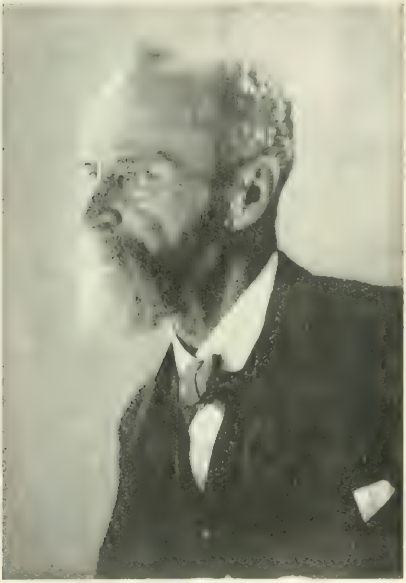
[1] *The Rod, the Root, and the Flower*, Coventry Patmore.

[2] *The Psychology of Adolescence*, by Prof. G. Stanley Hall, vol. ii, p. 294



PROFESSOR WILLIAM JAMES.

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Some of the visions of the saints have forms which are the same as those of the day-dreams of normal persons. Thus the Lady Julian records a vision which follows the outlines of the birth phantasy, but which has for her a religious significance: "And in this time I saw a body lying on the earth, which body showed heavy and horrible, without shape and form, as it were a swollen quag of stinking mire. And suddenly out of this body sprang a full fair creature, a little Child, fully shapen and formed, nimble and lively, whiter than lily; which swiftly glided up into heaven. And the swollenness of the body betokeneth great wretchedness of our deadly flesh, and the littleness of the Child betokeneth the cleanness of purity in the soul. And methought: *With this body abideth no fairness of this Child, and on this Child dwelleth no foulness of this body.*"[1]

Lastly, we may notice the very high valuation placed by religion on chastity. In mysticism, where the whole of the psychic energy is directed towards God, none can be spared for a human object of love. By a psychological necessity, absolute chastity is required for the mystic, and in religions in which the contemplative life is considered to be the highest, chastity is recognised as a desirable thing although it is not obligatory. It is an important, because it is a particularly difficult, part of the cutting one's self free from creatures which the mystics speak of as a necessary preliminary to entire devotion to God. An extreme example of this high valuation of chastity is found in the life of St. Louis of Gonzaga, who at the age of twelve, if by chance his mother sent one of her maids of honour to him with a message, "never allowed her to come in, but listened to her through the barely opened door, and dismissed her immediately. He did not like to be alone with his own mother, whether at table or in conversation . . . and he made a sort of treaty with his father, engaging promptly and readily to accede to all his wishes, if he might only be excused from all visits to ladies."[2]

A second point of importance in this connection is the common occurrence of conversion of a particularly emotional kind at adolescence. A very large proportion of conversions take place at adolescence, and these adolescent conversions have certain well-marked peculiar features of their own. They seem to be most satisfactorily explained by supposing that the growing energy of sex, which has been repressed by its failure to find satisfaction in a human love object, becomes directed towards God, but this redirection is less deep seated than in the case of the mystic. The emotional intensity of the adolescent conversion passes away, though it may leave behind it a religious sentiment which is permanent.

These facts do not compel us to the acceptance of a theory put forward by certain American psychologists under the name of "erotogenesis," which asserts that all religion is merely misinterpretation of sex-feeling. Simply on the psychological level, there are many other constituents of religion : group sentiment, the moral conflict, etc., all of which contribute to religious experience. Moreover, there is nothing in these facts themselves to justify us in concluding that the objects of religion are unreal. The fact that we love God with, in some sense, the same love as that with which we love man, is no evidence that our belief in God is an illusion. We have seen that this is substantially the conviction of such a firm believer in God as Coventry Patmore.

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[1] Cited in *The Graces of Interior Prayer*, by A. Poulain, S.J., chap. xxv.

[2] *The Life of Blessed Henry Suso*, translated by T. F. Knox, chap. x.

[1] *Revelations of Divine Love*, by Julian of Norwich, chap. lxiv.

[2] *Life of St. Louis of Gonzaga*, by Meschler; cited *Varieties of Religious Experience*, by W. James, p. 351.

It is, indeed, possible that investigations into the nature of religious experience along these lines may provide reasons for believing in the reality of its object. Freud considers that one of the causes of a large number of mental diseases is the failure of the psychic energy[1] to find satisfaction in an object of love. To a certain extent, it is possible to escape such mental troubles by the redirection of this energy into other valuable channels. This redirection is called "sublimation." Thus, the mind which devotes its energy to social work or to artistic production is less likely to become diseased through a failure to find happiness in love. If the mind retires too far from the world of realities and finds its sole satisfaction in a phantasy world of its own construction, it develops a form of insanity. In any very complete redirection of the psychic energy through religious channels, there is also a retirement of the mind from the outside world, but with a different result. The person concerned does not become mad. He has found an outlet for his psychic energy which provides him with a satisfactory basis for healthy mental life. There is a possibility that it is legitimate to argue that the satisfactoriness of the religious redirection of the psychic energy is the result of the fact that the object of religious love is real, and not, as many psychologists would have us suppose, a phantasy creation of our own minds.

We must, therefore, recognise the importance of this transformation of human love as a factor in religious experience. The emotions of the mystic and of the adolescent convert are emotions familiar to us in the sentiment of earthly love. The mystic's alternation of periods of intense emotional fervour and of reaction or "dryness," his temptation to find the meaning of his experiences in the emotional pleasures themselves rather than in the guided activity which should be their product, may be paralleled on the plane of human love. It is, however, important that the significance of this relationship should not be exaggerated. Probably we appreciate this significance best when we are led by it to see something sacred in human love, rather than when we find in it a cause of reproach to religious love.

BOOKS FOR FURTHER READING

ON THE PSYCHOLOGY OF RELIGION

The Varieties of Religious Experience, by William James. (Longmans, Green & Co., 12*s*. net.)

The Mystical Element of Religion, by Baron F. von Huegel, 2 vols. (Dent, 21*s*.)

The Religious Consciousness, by Prof. J. Bissett Pratt. (The Macmillan Company, New York, 1920, 22*s*.)

ON THE FREUDIAN PSYCHOLOGY

The Psychology of Insanity, by Dr. Bernard Hart. (Cambridge University Press, 1918, 2*s*. 6*d*.)

A General Introduction to Psycho-analysis, by Prof. S. Freud. (Boni & Liveright, New York.)

Metric Systems

By A. E. Crawley, M.A.

Author of "The Book of the Ball" and of "Lawn Tennis," etc.

AT the recent meeting of the British Association the suggestion was made that, in view of the decreased purchasing power of the penny, the pound sterling should be divided into two hundred instead of two hundred and forty pence. This would decimalise our coinage—sixpence would become fivepence, a shilling tenpence, half a crown twenty-five, and so on.

Periodical attempts are made to introduce a Bill for changing our system into a decimal system. But why not decimalise our weights and measures also ?

A uniform world-system of numeration would obviously be a boon to international trade, and other international relations. The Olympic games, recently held, showed once more the inconvenience of conflicting national systems of measuring. The 100 metres footrace is 109·36 yards ; the 400 metres race is 37·44 yards longer than our classic quarter mile. The equivalent of our mile is the 1,600 metres race of 1,640·4 yards ; and so on.

In the relative measurement of dress fabrics, as between, e.g., Switzerland and Great Britain in the silk trade, the reduction of the two systems, so Swiss merchants inform me, is a permanent nuisance, especially as the English yard and the Continental metre are *incommensurable*.

The essential points in a convenient system are ease of multiplication and division in small and large figures, and of automatic addition and subtraction in both. Here the decimal system, unwarrantably styled by many " the metric system " (as if " metric " were the adjective of " metre " only), seems to score. But the " point " or comma which marks off tens from hundreds and hundreds from thousands is easily misplaced, and sojourners on the Continent have often suffered in consequence. Another objection to Napoleon's system of numeration is that the franc cannot be so conveniently quartered as the old English shilling. Two and a half centimes (the quarter of a tenth of a franc) brings in the inconvenience of halfpennies, while threepence does not. Any unit of measure or weight or currency should be easily halved and quartered, the most primitive and permanent form of division and of fraction.

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[1] The word used by Freud is "libido." I have preferred to take the term "psychic energy" from Jung, since it is less likely to be given an exclusively sexual meaning. It is used as a term to cover the energy behind all kinds of desire.

The British methods (they can hardly be styled a system) of numeration in coinage, measures, and weights are a remarkable conglomeration of survivals from ancient systems. It is worth while enumerating the chief systems that have been used by man; a consideration of them will go to show that the decimal system (the so-called " metric " system *par excellence*, the World Trade Club's " meter-liter-gram ") is far from being a perfect system, and that there have existed better, at least for every-day use.

The way to consider these systems and to test them is to find their distinctive *unit* and examine its *divisional capacity*. Incidentally the multiplicational capacity will be remarked. The systems are in two groups, decimal and duodecimal (in twelves).

Most primitive peoples (the man in the street calls them savages, and Prof. L. T. Hobhouse the " simpler societies ") count by the fingers and toes, representing a convenient *abacus*. The method is not 1, 2, 3, 4, 5, exactly, but 1, 2, 3, 4, hand, and so on. It is curious that even now, in some English elementary schools, the counting is done similarly. A second " hand " makes up " half a man "; the two feet complete " a man." This is a quinary (in fives) system, well illustrated by the Roman numeral figures, I, II, III, IIII (IV = V minus I), V, the last being a pictograph of the held-up hand; VI, VII, VIII explain themselves, IX is X minus I, and X is a pictograph of two hands, XX of four.

As E. B. Tylor said, the decimal system, including the quinary and vicesimal (in twenties), was deduced from human anatomy. One great advantage of this group of systems is the principle of percentage. In the history of sociological arithmetic few things have been so useful as " per cent." On the other hand, decimal fractions do not come instinctively to the average mind, but, as on the Continent, the slightest instruction makes the method automatic.

The other great group of systems has twelve or sixty as its main units. The sixty system is traced to the ancient Babylonian culture, as is shown by the tablets of Senkerah, sixty being a *soss*, and sixty by sixty a *sar*. Sexagenary applies to multiplication by sixty, sexagesimal to division of or by sixty. Ptolemy, in the second century, applied this system to the calculation of degrees. He made the degree sixty, the minute a sixtieth of the degree, and the second a sixtieth of the minute. The Roman and mediæval mathematicians adopted the system, and exploited it further, in the calculation of time. They divided the day into twice twelve hours, the hour into sixty minutes, the minute into sixty seconds. In mediæval Latin the divisions of the sixty unit were *partes minutæ primæ*, and of these the sixtieth parts were *partes minutæ secundæ*. Hence our terms minutes and seconds, both for time and space.

A curious remainder of this sixty-system, as the present writer has shown, is in the scoring of tennis by fifteens. This has been a puzzle since 1555, when the Italian Scaino attempted to solve it. The game was a unit of sixty divided into four strokes—fifteen, thirty, forty-five, and sixty. To this day, in France, the original forty-five is used in *la paume*, our tennis, instead of our abbreviation forty.

The reason behind the selection of 60 as a unit is clearly the fact that it is *divisible by more numbers than is any other*. Sixty is divisible by twelve numbers, 1, 2, 3, 4, 5, 6, 10, 12, 15, 20, 30, 60, and is halved and quartered conveniently. Ten, the unit of the decimal system, is divisible by four numbers, 1, 2, 5, 10, and cannot be quartered without a fraction. Twenty, the unit of the vicesimal system, is divisible by six numbers; so is twelve. A hundred is divisible by nine numbers. The duodecimal (twelve) being multipliable into sixty, as in clock reckoning, and thus including twelve sets of fives, is, in this larger form (the sexagesimal), superior to the decimal, whose half-unit is five, and which cannot be quartered without a fraction. The decimal system retaliates by dividing its units into tens, hundreds, thousands, etc., and multiplying them into trillions. But Tylor concluded that " duodecimal arithmetic is a protest against the less convenient decimal arithmetic in ordinary use."

The British numerational methods comprise halving and quartering, and the various forms of the decimal and duodecimal systems, viz. quinary, decimal, vicesimal, centesimal; and senary (six), duodecimal, and sexagesimal.

To take the salient instances, halving and quartering, of course, are universal, with a curious preponderance in dry measure and liquid measure. Thus, a bushel divides into four pecks, a peck into two gallons, a gallon into four quarts (i.e. quarters), a quart into two pints; a pint, a peck, and a pound are each divided into "quarters." Again, a pound is divided into sixteen parts (ounces) in avoirdupois. The fact of having troy and avoirdupois is confusing; merchants recently have been discarding the former. Four "quarters" go to a hundredweight, and eight stones to a hundredweight. In measure, one mile divides into eight furlongs, two half and four quarter miles; and four fingers make one palm, sixteen fingers one foot.

The decimal and duodecimal systems fit in with this halving and quartering very neatly. One pound[1] is twenty shillings; "half a sovereign" is ten. A shilling is twelve pence; half a crown is thirty; a crown (now obsolete) is sixty. It is like tennis scoring, although the coinage lacks pieces of fifteen and of forty-five pence. In France, between 1310 and 1410, there was a predominance of coins value fifteen and sixty. When you have quarters, halves and three-quarters need not be separately struck. Further examples of the duodecimal and sexagenary systems—a "pound Scots" is one shilling and eightpence, one-twelfth of a pound; one dram is sixty minims; one "pennyweight" is twenty-four grains; the ell is two-thirds of sixty inches; twelve ounces (troy) are one pound.

One sees something in the Roman single principle that an *uncia* was the twelfth of anything, and an *as* twelve times anything, coin, weight, or measure.

But the writer, though he has an antiquarian predilection for the duodecimal and sexagesimal systems, is aware that their usefulness is in division only, and of small amounts; he would therefore welcome a wholesale introduction of the decimal system.

Arrested Inventions

By Herbert W. Horwill, M.A.

WHAT is, perhaps, the most sensational of recent triumphs of invention—the conquest of the air—was long overdue. Ever since the day when Icarus presumed too greatly upon the skill of his father, Dædalus, the world has been prepared to hear any morning that man had at last acquired the powers of the bird. Indeed, one might almost say that there has been more disappointment at earlier failures than astonishment at the successes recently achieved. It is not in this section only of the wide field of invention that each stage in the process has been curiously hampered by a difficulty about the next step. "A little more and how much it is." Again and again a promising advance has been brought to a halt by an obstacle that, in the retrospect, seems almost trivial. It may be that generations or even centuries pass before there flashes into someone's mind the illuminating idea that enables this hindrance to be surmounted.

This arrest of invention has been abundantly illustrated in the history of transit by land as well as by air. In view of the part that steam has played in modern methods of transport, as well as in industry generally, one is amazed to learn that its use was anticipated early in the Christian Era. In a treatise written about A.D. 130, Hero of Alexandria describes a hollow spherical vessel turning on an axis, which vessel was supplied with steam and driven by the reaction from escaping jets. Yet the belief that there could be any mechanical value in the expansive power of steam seems to have slumbered through the ages, not to awaken until the seventeenth century, when there began the series of experiments culminating in Watt's famous invention of 1769. A crude anticipation of the modern railway existed near Newcastle-on-Tyne as long ago as 1676, when coals were conveyed from the mines to the river along parallel rails of timber. "Bulky carts were made," so we are told, "with four rollers fitting those rails, whereby the carriage was made so easy that one horse could draw four or five chaldrons of coal." The story of the various contrivances that prepared the way for George Stephenson's railway engine is familiar to all students of our industrial history. The motor-car of our own time certainly appears to be one of those inventions that should have come earlier, when one remembers the road locomotives of Oliver Evans in America and of Trevithick in Wales more than a century ago. It is now generally known that one of the latest adjuncts of the public motor, namely the taximeter, was used by the Chinese. Vitruvius, too, who flourished before the Christian Era, describes a practical taximeter which the Romans attached to their chariots. Perhaps even the development of steam navigation might have been expected sooner, inasmuch as the ship's paddle is only an application of the familiar water-wheel, and the screw propeller an extension of the vanes of the windmill.

Still more remarkable are the instances of long delay in the discovery of improvements in the arts that have to do with reading and writing. How strange it seems to-day that so many centuries of literary activity should have passed before anything corresponding to our "running hand" was thought of! One is surprised that the painfully slow process of writing in capital letters, or in that kind of half-capital which is known to [illegible] metal should have survived so long after the primitive carving of literature upon stone had been superseded by the introduction of papyrus and parchment. A glance at any collection of ancient manuscripts of the fourth and fifth centuries A.D. makes one wonder also that no Greek or Roman writer of that period should have seen what an advantage it would be to separate successive words by blank spaces, as had been regularly done on inscriptions both at Athens and Rome in earlier times.

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[1] The origin and the reason of the survival of the guinea do not come within the scope of this article. It might be pointed out, however, that one of the reasons why it is cherished by lodging-house and hotel keepers is that it is divisible by *seven*, the number of days in the week.

Though the European world had to wait until the fifteenth century for the invention of printing as we know it, many of the most important elements of this art were familiar long before. The existence of coins in remote antiquity shows that the use of moulds was early understood. In the time of Virgil, brands with letters were used for marking the owner's name on cattle, and articles of merchandise were stamped by a similar process. Yet, while coming so near the epoch-making invention of movable type and the press, the Romans had to depend upon the labour of scribes to reproduce their documents and books—and newspapers—for they were "progressive" enough to publish a daily gazette. In discussing this topic it is inevitable to refer to the Chinese, who printed from wooden blocks in the tenth century of our era. The development of the art is often supposed to have been arrested in their case by a failure to take the next step of separating characters in the form of movable types, but it has lately become known that they were actually doing this four hundred years before Gutenberg set up his press at Mainz. There seems to be no evidence, however, that the Chinese anticipated Schöffer's plan of casting these types from matrices, instead of cutting them individually. It is worth noticing, by the way, how one of the most important later developments of printing has been, in a sense, a reversion to the earliest methods of all, for, when you print from a stereotype plate whose component letters cannot be "distributed" and used another time, you are once more printing from a solid block. A detailed examination of the successive improvements in the mechanism of the press itself and in the various devices for "composing" by machinery would illustrate in like manner how success has been reached by a series of stages, with long halts between. The typewriter, again, is an invention that has passed through a long apprenticeship, for as long ago as 1714 a patent was taken out in this country by Henry Mill for a "machine for impressing letters singly and progressively, as in writing, whereby all writings may be engrossed in paper, so exact as not to be distinguished from print." The next step was not taken until more than a hundred years later, when the "typographer" was patented by an American, W. A. Burt. Before departing from the literary side of our subject, it may be as well to recall that the card catalogue—that convenience of the modern library—first suggested itself to the ingenious mind of a French abbé of the Revolution period. He wrote the titles of his books on playing-cards, and arranged them endwise in alphabetical order on a tray. But the first general application of the idea was made by an American librarian in the middle of the last century.

Photography is an art that several times seemed on the verge of being discovered. A camera obscura was exhibited by Battista Porta in the sixteenth century, and there are records of such cameras even before his time. Thomas Wedgwood succeeded at the beginning of the nineteenth century in making profiles by the action of light upon silver, but it was many decades later that the attempt to take portraits by similar means became anything more than the curious hobby of an experimenting chemist. There is a number of other inventions—including the mariner's compass, gunpowder, and the sewing-machine—whose history it would be interesting to trace. But of all the examples of arrested development in the application of mechanical methods there is none more peculiar, in some respects, than one revealed by an incident which occurred in a British colony. About 1842 the area under wheat cultivation in South Australia had increased far beyond the capacity of the working population to reap the harvest. So urgent was the need of help that the Imperial troops then doing duty in the colony were ordered into the fields to assist. Thereupon a local miller named Ridley devised a labour-saving machine called the "stripper," which, while it was being drawn through the corn by a pair of horses, pulled the heads off the straw and threshed them. This immediately reduced the cost of harvesting from 2*s.* to 3½*d.* a bushel, and made the growth and export of grain a flourishing industry. Now, the odd thing is that Mr. Ridley derived his "happy thought" from an article in an old encyclopædia about a reaping-machine worked by oxen on the extensive plains of Ancient Gaul, and described by the Latin writers on agriculture. To use a metaphor appropriate to the subject, could one imagine a more remarkable instance of an idea becoming fruitful after lying fallow for many centuries?

It is tempting to speculate on the causes which have at one time and another prevented the rapid development of the germs of invention. Sometimes the peculiarities of national temperament seem in large measure accountable. It cannot be by a mere accident that China provides so many examples of arrested growth, while her neighbour, Japan, with less power of origination, has borrowed so many Chinese contrivances, in the fine arts as well as in mechanics, and has improved on them. Much depends also upon social environment. Among the Romans the existence of large resources of slave labour discouraged the exercise of ingenuity. What stimulus was there toward inventing means of rapid reproduction of documents when slave copyists were at hand? Account must also be taken of the fact, noted by the late Professor Bain in his *Mental and Moral Science*, that as a rule it is only in modern times that the perception of similarities has been a force making for invention, as in the case of the "governor balls" of Watt. And, of course, we must never forget what mechanical progress owes to the enunciation of Bacon's great maxim that we cannot conquer Nature save by obeying her laws.

Reviews of Books

A Textbook of Plant Biology. By W. NEILSON JONES AND M. C. RAYNER. (Methuen & Co., 7*s.*)

An Introduction to the Structure and Reproduction of Plants. By F. E. FRITCH AND E. J. SALISBURY. (G. Bell & Sons, 15*s.*)

There has recently been a fairly general tendency on the part of botanists to modify their methods of teaching; for many years the practice was to illustrate the characters of the various groups of plants by the description and examination of seleeted types, to pay comparatively little attention to the chemistry and physics of the living organism, and to emphasise form and structure rather than the methods by which plants live and react to their environment. The enormous advance in recent years in our knowledge of Biochemistry, that is the chemistry of living things, has demonstrated the importance of introducing the student at an early stage to the conception of plants as working machines requiring energy, and depending for their efficiency upon chemical reactions in the living cells. The more old-fashioned methods of presenting the subject did not sufficiently recognise the unity of life. It is still difficult for many people to grasp the fact that plants are just as much alive as animals, and that the two kingdoms represent divergent lines of evolution from common ancestors which were neither plants nor animals as these are generally understood.

The book on Plant Biology by Professor Jones and Dr. Rayner is divided into three parts: The plant as a machine; the plant in relation to the outside world; reproduction. Throughout the volume there are directions for simple and well-chosen experiments. A student who has mastered the course of study proposed cannot fail to realise the nature of the problems with which a plant is confronted and the means by which the problems are solved. As the authors point out, their book does not profess to be a general treatise; it introduces the reader to the fundamental principles of Biology, and encourages him to see things for himself and to take as little as possible on trust.

The volume by Professor Fritch and Dr. Salisbury is a sequel to their *Introduction to the Study of Plants*, and while complete in itself, within the limits suggested by the title, it is primarily a textbook for students who wish to carry the study of plants beyond the stage at which a knowledge of minute structure and details of life-histories was not demanded. The authors state that they have "abandoned the study of isolated types in favour of a more general account, indicating the range of form and reproductive methods within each group." They have also endeavoured "to combat the frequent ignorance of botanical students with respect to the ecomonic aspects of their subject." The book is clearly written and on the whole well illustrated; the comparative method of treatment is an attractive feature to which greater prominence is given than in many textbooks. The physiological side is not neglected, and as far as possible structure and function are considered together.

These two volumes may be recommended with confidence as trustworthy guides to the modern method of studying botany, and the latter volume forms a suitable companion to that on Plant Biology. In both the subject is made attractive by a breadth of view and by emphasis on physiology. Elementary students with some knowledge of chemistry and physics can easily follow both pairs of authors; advanced students will learn a good deal, and the teacher will find many useful hints for practical exercises and methods of presentation.

A. C. SEWARD.

Devonian Floras: a Study of the Origin of Cormophyta. By E. A. NEWELL ARBER, with a Preface by DR. D. H. SCOTT. (Cambridge University Press, 17*s.*)

This book was prepared for the press by Mrs. Arber from a first draft written by Dr. Arber shortly before his death in 1918. Dr. Scott, in the Preface, gives a brief summary of the several chapters, and writes sympathetically of the "bold and vigorous effort" made by the author to grapple with the problems of evolution presented by the oldest known land-plants. Dr. Newell Arber, of whom an excellent photograph is reproduced as a frontispiece, was one of the most devoted workers in the attractive field of palæobotany; his researches added very considerably to our knowledge of fossil plants of different ages, and his more general papers dealing with questions of theoretical interest were both able and stimulating. In this his last work he gives an admirable summary of the salient features of Devonian plants described from many parts of the world, and discusses, with much independence of thought and originality, the bearing of the botanical data upon the evolution of the earliest land-plants. The theory advanced in the latter part of the book, which had not been revised by the author, of the origin of the Cormophyta—that is, plants exhibiting a differentiation into definite organs performing different functions—raises many controversial questions;

and while his conclusions will doubtless meet with some adverse criticism, they represent a solid contribution which is in general harmony with the ideas of certain other investigators who are dissatisfied with the more orthodox views on evolution.

Dr. Arber's essay was written after the publication of the first of the series of memoirs by Dr. Kidston and Professor Lang on the structure of the Middle (or possibly Lower ?) Devonian plants discovered a few years ago by Dr. Mackie in Aberdeenshire; but he did not live to see the later parts, the contents of which would probably have led him to reconsider some of his conclusions. Dr. Church's essay on "The Thalassiophyta and the Subaerial Transmigration," referred to in a previous number of DISCOVERY, would undoubtedly have appealed with considerable force to Dr. Arber had he lived to see it.

Unfortunately, most of the remains of the oldest known land-plants preserved in the rocks of the earth's crust are fragmentary, and with few exceptions afford little evidence of anatomical characters; the literature in which they are described is scattered, and in many instances difficult to obtain. But such records as there are demand the closest scrutiny by seekers after origins. Dr. Arber's concise descriptions of the several genera are particularly welcome, aided as they are by many well selected and admirably reproduced illustrations. The older Devonian flora, called by the author the Psilophyton flora, from the occurrence in many localities of the genus *Psilophyton*, differs widely from the latter, or *Archæopteris*, flora, which includes undoubted ferns and other Vascular Cryptogams, with a few representatives of trees presumably bearing seeds. It is contended that the members of the Psilophyton flora should be regarded as Thallophyta, despite the fact that in their organisation they had advanced beyond the limits of that group as we now understand it. The most highly differentiated living thallophytes are certain seaweeds adapted to life in water, but in the older Devonian thallophytes it is maintained that we have an added complexity of structure which was the result of their transference to a terrestrial habitat. The different groups of vascular plants represented in the Upper Devonian rocks are believed to have been derived from different ancestors which were algal in nature, a view which has much in its favour.

In Dr. Arber's book the student conversant with the general trend of modern speculation on the evolution of plants and with recent palæobotanical researches will find much to interest him and to make him think.

A. C. SEWARD.

Instinct and the Unconscious. By W. H. R. RIVERS, M.D., F.R.S. (Cambridge University Press, 1920, 16*s.*)

Let it be said at the outset that Dr. Rivers has given us a book that must be read and discussed, and that will be enjoyed whether or no it will be agreed with. Although confining himself to broad principles, he yet breaks new ground; and by laying stress on the biological side of psychology, he does a service to both sciences.

The contrast between a treatise such as this and the textbooks of psychology in vogue twenty and thirty years ago is remarkable. There is a new spirit in the air, and the new spirit is the outcome of a new method. In chemical science, the outstanding feature of modern times has been the rise of physical chemistry. The study of processes has proved the most illuminating and economical method of dealing with the multiplicity of fact; the dynamic has supplanted the static.

The same change is coming over psychology. We used to think of a curious being called the Ego installed somewhere in the chariot of the brain, and driving a rather mixed team of horses—Will, Intellect, Emotion, Memory. There was, of course, a certain amount of interaction—now and again Emotion would kick Intellect, Memory would jib and pull the rest up, or Will would need a touch of Ego's whip; but on the whole there wasn't much trouble of that sort, and good driving would get the team along.

To-day, charioteer, chariot, and horses alike are lost, merged in the conception of a single co-ordinated whole whose parts, though differentiated, are all in a state of equilibrium one with another, so that one cannot be altered without altering all the rest.

The most important single aspect of this state of balance is the dominance of some parts over others. The whole nervous system, whether regarded on its mental or its purely neural aspect, is a hierarchy, in which every part is being controlled from above, and is controlling other parts below. Normal mental health consists in striking the right balance between the lower centres—for the most part those concerned with the primitive instincts—and the higher centres—those concerned with altruism, with the highest types of emotion, and with the reason. As Dr. Rivers points out, this balance can be upset in either of two opposite ways, but with the same general result. Either the subordinate processes may be unduly strengthened, or the controlling processes may weaken. The conflicts of adolescence are due to the former cause, the neurasthenia and so-called shell-shock of adults to the latter.

It is of the utmost interest to find close parallels between the mode of interaction of the parts of the mind and that (at least in the simpler, more plastic organisms) of the parts of the body.

In the organism, regarded merely as a physiological machine, we are also brought face to face with a system composed of a number of parts in equilibrium, some parts being dominant over others. It is impossible to go into details here, but those who care to pursue the subject in books like Professor Child's *Individuality in Organisms*[1] will find the most suggestive parallels.

How comes it that such parallels exist? It proceeds from the fact that the only type of living system which can succeed in the struggle for existence must possess both diversity and unity. It must possess diversity to cope with the different problems propounded to it by the environment, it must have unity in order to subordinate one function to another according to circumstances, in order to be able to bring all its forces to bear upon any one particular problem. With the diversity we are familiar enough. The unification, however, is not so familiar. A very specialised method for achieving it is seen in the ductless glands of vertebrates; more primitively, we can simply say that each part has a reaction upon every other part, whether chemically or mechanically, so that the whole is not merely the sum of the parts, but the sum *plus* the interaction of the parts. This has long been known; but the relation by which a higher, controlling portion regulates and inhibits the rest—this has only recently come to the fore as a general principle of biology.

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[1] C. M. Child, *Individuality in Organisms.* Chicago, 1915.

In a worm the front end of whose body has been cut off, the first structure to regenerate is a head; this once formed, the other missing organs are formed in due relation to and at normal distance from this head. But if we prevent the formation of a head, as we can by cold or by narcotics, the rest of the missing organs will never form. In a similar way, in the normal man there are certain reflexes which the spinal cord will carry out. When the connection between cord and brain is severed, these reflexes disappear, and, as Head and Riddoch have shown, quite new and much more primitive reflexes (of the sort that characterise toads and other low vertebrates) take their place. How is this possible? Normally, the reflexes are compounded of the activities of the spinal cord and the controlling influence of centres in the brain: remove the latter, and the unmodified activity of the cord appears as something new.

Many other parallels could be drawn, particularly between dedifferentiation, when whole organisms revert to a simpler stage, and regression, when human minds run back to the state they exhibited in childhood: but space forbids. The comparison is of value, however, for it demonstrates—what specialisation is always doing its best to obscure—the essential unity of all life.

The bulk of Dr. Rivers' book is devoted to the different types of neurosis and psychosis—anxiety-neurosis or neurasthenia, hysteria, dissociation, regression, phobia due to repressed complexes, and so forth, with a discussion of the underlying concepts—of instinct, suggestion, suppression, sublimation—on which he bases his analysis.

In accordance with the dynamical idea set out above, he considers all the abnormal mental conditions as upsets of equilibrium which represent crude and inadequate methods of attempting to solve a conflict between parts of the mind. The properly-developed mind is one in which every part, even the "lowest" instinct, is strong and active, but every part is properly subordinated in its due place in the hierarchy. An instinct is only bad when it escapes from control. Repression of primitive instincts and emotions is a mere drying of the springs of action. It is when instincts are powerful but sublimated rightly—piped off to drive the wheels of intellect and will—that real health of mind is found.

There is one general criticism which may be raised. It is a curious commentary on the method by which science progresses that the psychologists and physiologists are now laying that great emphasis upon adaptation which they deplored in the biologist forty years ago. The biologist meanwhile has moved on, and, while fully conscious of the importance of the adaptation-concept, is finding that much of what he thought at one time to be adaptive is in reality a direct and necessary consequence of the constitution of living matter. Dr. Rivers thinks of the psychological mechanism of suppression as having come into existence in response to a need for more delicate graduation of response in some cases, for immobility in others; he looks for the cause of dissociation in the alternation of land and water in the life of Amphibia. There is much to be said for this view; but the future will probably show that it is not the actual mechanisms which have originated thus, but only specialised conditions of the mechanisms, which themselves are inevitable by-products or ingredients of a highly-organised nervous system.

An analogy from biology will make my meaning clear. The property of regeneration is obviously useful to the organisms which possess it. Which of us would not like to be able, if we lost a hand or a head, to grow a new one? During the latter half of the nineteenth century it was strenuously maintained by leading zoologists that the power of regeneration was adaptive, and had originated during evolution through natural selection. A careful study, however, of the method and occurrence of regeneration has shown that this is not so. Regeneration is an inherent property of life, a necessary outcome of the fact that an organism is a system in equilibrium, and that, when that equilibrium is upset by the removal of a part, it is re-established in the same way as is a chemical equilibrium. Later on, in some organisms, this power has been specialised, adaptively, while in others it has been sacrificed to more important qualities.

Mental dissociation is probably a close parallel. Given a psycho-neural system capable of associative memory, a break between one part of the system and another may be made by various agencies; and if this happens, the two divided parts will round themselves off into a condition of equilibrium and be capable of a more or less independent existence: the possibility of dissociation is given by the nature of the system itself. No doubt but that machinery for more prompt and efficient dissociation (as in animals exhibiting immobility in response to danger) will be later developed through natural selection. Similarly with hypnotism. Given some mechanism of suppression and of suggestion, a large part of the phenomena of hypnotism follow naturally, without our having to ask what the biological meaning of hypnotism may be.

This is not to detract from Dr. Rivers' brilliant use of the biological method, which illuminates biology equally with psychology: it is merely to point out a limitation and to suggest another view-point which, as a matter of fact, has abundantly justified itself by results in the parallel but more developed science of biology.

Dr. Rivers' judicial view of the position of Freud and his theories in modern psychology will, it may safely be asserted, prove to be that which will be adopted by the historians of science. The experience of the war has mean that Freud was wrong in one essential: sex does not necessarily underlie all neuroses. Any primary instinct may do so; and in war it is the conflict between fear and the higher centres which is by far the commonest cause of conflict. But in a still more fundamental matter, Freud was right. He drew attention for the first time to the mental mechanism by which these abnormal states arise. The concept of suppression, of active but instinctive forgetting of the unpleasant, with subsequent formation of complexes, is, as Dr. Rivers rightly says, one of prime importance to the theory and practice of psychology.

We hope that Dr. Rivers will give us a continuation of his essay. Case-records analysed from his particular standpoint, with detailed parallels from biological sources would be immensely interesting. So, too, would be a consideration of neuroses in savage peoples—a task which Dr. Rivers would be peculiarly qualified to undertake. A new " Golden Bough " on psychological lines . . . we close in pleasurable anticipation of such a possibility!

J. S. Huxley.

Miscellany

A revised edition of the famous Greek Lexicon known to all students as Liddell and Scott is shortly to appear. The last edition was revised in 1897 and published at two guineas; the forthcoming edition will be sold at four guineas, or in separate parts at a slightly higher figure. The need for a revision has long been appreciated by the Oxford University Press. The discovery, since the last substantial revision of the Lexicon, of the *Constitution of Athens*, the poems of Bacchylides, the mimes of Herodas, and a large number of fragments of classical literature, both from the works of authors such as Hesiod, Pindar, Sappho, Alcæus, and Callimachus, and from those of other writers who were previously little more than names to us, has added a considerable number of new words and early examples, or new uses of known words. The study of the numerous non-literary papyri has immensely widened our knowledge of Hellenistic Greek, and has introduced us to a new technical vocabulary in connection with the administration of Ptolemaic and Roman Egypt. During the same period the discovery of fresh inscriptions and the correction of the text of those already known have been constant. The science of Comparative Philology has been transformed and the history of the Greek language more fully explored. It is good, therefore, that the Lexicon should include all the necessary additions and modifications, and drop out (as it is doing) words from late or ecclesiastical writers whose place is more properly in a lexicon of Patristic Greek.

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The Cambridge University Press hope to publish by next October the first of a series of monographs on recent developments of physics which shall serve as supplements to Dr. N. R. Campbell's *Modern Electrical Theory*. It is difficult to keep such a book abreast of the times by means of new editions; accordingly the plan is proposed of issuing monographs, each corresponding roughly to a chapter of the book, the collection of which will in due course replace the book.

The monographs will be edited by Dr. Campbell, but he will not write all of them. The authors will not be, however, experts in the branches of physics concerned, for it is felt that a critical survey of a subject such as is appropriate to a textbook is more easily adopted by those who have not made important contributions towards it.

The first three monographs of the series will deal with Spectra, the Quantum Theory of Energy, and the Constitution of Atoms and Molecules.

This is extremely sound sense. The problem of keeping a scientific book reasonably up-to-date is a difficult one. One way is by the method described above; another is by issuing the book in a loose-leaf form. In the latter case those pages containing statements which subsequent work has rendered out-of-date may be easily removed, and pages, issued to purchasers of the book by the publisher, containing the latest and most acceptable views inserted in their places.

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Pessimists must be having a bad time of it at present. So many people are giving them nasty knocks. Publishers, for example, will persist in bringing out the most excellent books, carefully edited, nicely printed, and pleasantly bound, as though they were completely in ignorance of the pessimist's view that the world has gone completely to the dogs. The Cambridge University Press is going to bring out a new edition of Shakespeare's works. Sir Arthur Quiller-Couch is joint-editor with Mr. Dover Wilson, the well-known authority on the text of Shakespeare. It is quite evident that the series will be a most valuable one. It is true that editions of Shakespeare multiply; but it is now many years since the last attempt was made at a complete recension of Shakespeare's text, based upon a study and comparison, line by line, of the existing materials. And it is refreshing, after a study of Shakespeare at school, to read through an edition containing the text as near as can be discerned to that given by the author to his printer under the well-informed, clear, and accurate guidance of " Q " and his collaborator. The first of the series—*The Tempest*—has already been published.

The Oxford University Press is issuing a series of little books dealing with international, financial, industrial, and educational problems of to-day. Each book deals with a subject in a simple but authoritative manner. Instead of getting anybody to write these books, Mr. Victor Gollancz, the editor of the series, hit upon the excellent idea of asking men to write who really knew what they were writing about. The result is a series which one may confidently recommend to our readers. Sir Harry Johnston writes of the Backward Peoples and our relations with them; Mr. Baumann, of *The Saturday Review*, is writing on The Press, Mr. A. G. Gardiner on the Anglo-American Future, and Professor Pigou, of Cambridge, on A Capital Levy and Levies on War Wealth. About twenty volumes have been, or shortly will be, issued. Each has about seventy pages and costs half a crown.

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Editorial Notes

I am going to allow correspondents to get a word in edgeways this month. One writes, "In your Editorial Notes in the March issue you mention the possibility of an expedition to climb Mount Everest. If it be not too late in the day, might I ask in all seriousness what is the use of such a climb? Does it do any good? Are the scientific results hoped for (I suppose the expedition is going to be a scientific one) worth the trouble and the expense? Barring the view, what does anyone expect to find at the top? Isn't it time that this kind of thing were looked upon by all decent people in the same light as attempts to reach the North and South Poles—namely, a pathological manifestation, or, in less technical language, a singularly futile waste of energy and good money?"

* * * * *

I do not agree with this view. If one went on tour, hired halls and delivered addresses on the value of science, what would one say? This, that every fact discovered, every conquest of our surroundings, is a step forward in the upward march of humanity. It may lead to great developments. Of course, it may not. The important thing, however, is that it *may*. All the discoveries of modern science are based on the patient work of those who have laboured to discover the secrets of nature without caring twopence whether or not they were of "practical value." No one should say to these men, "Do this particular thing; go in this particular direction; drop this, it is too expensive." All things must be tried; all avenues explored. After all, in this particular case, what is ten thousand pounds (the cost of the expedition)? It is not going to "burst" a wealthy nation like ours. And a score of men only out of a population of forty-five millions are being detached from, shall we say, utilitarian ends to pursue this new adventure. Should it fail, the world will still go on. Indeed, is it not true to say that the world, except in a material sense, would long ago have ceased had it not produced in all ages the men and women who could resolutely attack a difficult piece of work like the ascent of Everest?

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The President of the Royal Geographical Society, as reported in the March issue of *The Geographical Journal* (p. 204), has expressed the same idea in better words: "I entirely agree with what Sir Ernest Shackleton said about the necessity of a spirit of adventure being behind these [Polar] expeditions. But I think that the two—the spirit of adventure and the pursuit of science—go admirably together, because when men of adventure go into these terrible places, they like to feel that all their efforts and all the hardships they undergo may result in the attainment of some knowledge which will be of real use to the human race. I suppose that it is the adventurous spirit which all scientific men need in their pursuits. Unless they had it behind them in their work, they would not get very far even in laboratories. After all, it is only a matter of time before all the items of knowledge do come in useful for 'the amelioration of the lot of mankind.' It may be sooner or it may be later, but in the long result the utility of each will be found. The human race will never be satisfied until it has completed its knowledge of its surroundings. We want to know everything about this planet, even its furthest confines, because we not only have to adapt ourselves to our surroundings, but in the true spirit of man we have to master them."

A correspondent in Castlereagh, County Roscommon, has sent me an interesting note concerning Peary's claim to have visited the North Pole. He is inclined to side with the American Senator, whose view on the subject I quoted in a previous issue, and gives his reasons for doing so. I once heard a man "settle" this problem from a comfortable seat before a gas-fire. He argued that Peary probably did not get there, but as he had tried several times unsuccessfully to reach the Pole, as he was very very anxious to do so, and as he knew that the expedition of 1909 must be his last, what was more natural than to say he got there whether he did or not? It seems an unfair argument, but the man had studied the psychology of the whole affair—Peary's doing the last stage of the journey without a white companion, etc.—and that was his view. Whatever be the truth, there is no doubt that Peary was a great man, a resolute and adventurous discoverer. It might be interesting to quote Sir Clements Markham's opinion of the rival claims of Cook and Peary from *The Lands of Silence*,[1] a really excellent book on Arctic and Antarctic exploration which has just appeared. It seems to me very just and not too non-committal:

"Peary was preceded by a similar attempt, made with much smaller means, by his former colleague, Dr. Cook. . . . Dr. Cook had been ethnologist in Peary's first expedition, and had acquired the Eskimo language as spoken by the Arctic Highlanders. He had also served in the Belgian Antarctic expedition. . . . The final start was made on March 18, 1908, the travelling being difficult owing to the lines of hummocks caused by ice pressure and the lanes of water. On March 30 Cook sighted land to the westward in 84° 50′ N. which he named Bradley Land, but he did not alter his course to examine it. On April 21 he reports having taken a sun's meridian altitude, which gave a latitude of 89° 57′, but he must have been mistaken, both overrating his distances and failing to make sure of his direction by observations. He doubtless did make a long journey over the ice, in a more or less northerly direction; but without observations to obtain true bearings, no reliance can be placed upon his positions.

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"Cook's instruments were a sextant, and a glass artificial horizon adjusted by screws and spirit level. He also relied on shadow observations, and on an odometer fitted to his sledge. But there is no mention of any observations for true bearing of the sun, and that he made none is conclusively proved by the fact that in returning he was unable to follow his outward tracks. . . .

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"On March 5 [1909] they [Peary and his party] came to a lane of open water, which detained them for several days owing to lack of means for crossing it. During five days Peary paced up and down deploring his luck. Afterwards they crossed seven lanes of water on young ice. Bartlett was the last to return, after taking an observation with the resulting latitude of 87° 46′ 49″ N. Thus 280 miles had been traversed in a month, and they were 133 miles from the Pole. The speed had been calculated at under fifteen miles a day.

* * * * *

"From this spot Peary went on for the Pole with only his negro servant and four Eskimos, five sledges and forty dogs. It was a great mistake to enter upon what he considered the most important part of his journey without any white companion, more especially as bearings and distances do not appear to have been ascertained by observations. For help in making these rough estimates, and for such observations as were taken, a colleague was imperatively necessary.

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"Directly Peary parted from Bartlett, his estimated distances were more than doubled, and the course was assumed to be due north. Peary refers to the meridian of Cape Colombia as if he had never deviated from that meridian during the whole journey. Without such observations it would not be possible to keep on the same meridian. Yet after journeys during four days estimated at from twenty-five to thirty miles a day, a meridian altitude of the sun was taken which gave a latitude of 89° 25′ N., or 97 miles due north from the position where Bartlett observed. Without amplitude observations this would not be possible, so that there must be mistakes in the observations for this and subsequent meridian altitudes. The sun was very near the horizon at noon at that time of the year. The distances were, perhaps naturally, overestimated. Peary was very fortunate in being able to follow his tracks during his return journey, in spite of a furious gale which might have obliterated them."

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Several correspondents have written me about one of the puzzles in Mr. Stewart's article in the March number—the one that seeks to show that a half-yearly rise of £10 is better financially than a yearly one of £40. This was stated to be a straightforward problem, not a catch. Opinions seem to be, however, that either it *is* a catch, or if not the half-yearly rise proposed is *not* better than the yearly one.

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I quote as an example of the letters received from one sent me by a major in the Sappers: "The 'salary' problem *does* contain a catch, or, alternatively, Mr. Stewart has not calculated the salaries in accordance with the data given. The original salary is given as £400 *per annum.* Any rise of salary given later (according to ordinary practice and failing a definite agreement otherwise) is an increase in the *rate* of salary, and *not* in the amount of actual cash paid at the time of the increase. The second half-yearly payment made should, therefore, not be £200 + £10, but (£400 + £10) ÷ 2 = £205, and the series of half-yearly payments should read:

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[1] Published by the Cambridge University Press, 45*s*.

" First year:
£200
£205
£405

" Second year:
£210
£215
£425

" Third year:
£220
£225
£445."

* * * * *

I agree that an employer might be tempted to interpret the bargain in this way. I think, nevertheless, it is a wrong interpretation. The problem stated that the employee was engaged at a salary which *commences* at the rate of £400 per annum. Correspondents have led themselves astray by assuming that the man must continue at this rate for the first year. But why should he? What is a half-yearly rise at all unless it becomes operative every six months? Several people think he should wait for the first rise till twelve months were up. But this is quite unfair. What would a man, engaged to receive an *annual* rise, think of his employer if he had to wait till the end of *two* years for it? And why should the cash value of the rise be modified in the least? A periodic rise of £10 surely means that in any length of time equal to that period the employee receives £10 more than in the preceding period. It seems to me, therefore, that the problem is quite straightforward and was correctly demonstrated by Mr. Stewart.

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Apropos of my remarks on telepathy in the March issue, a correspondent sends me the following interesting letter:

" Dr. Paul Bousfield's 'Mr. X' is the same gentleman who 'obliged' by going out of the room in the 'parlour-games' of our youth—the poker and the hairpin are old friends.

" There was another pastime of our youth which was on all-fours with the 'simple but illuminating description of telepathic power' given by Dr. Bousfield in his book. It was much more interesting to fix upon some member of the congregation, during the sermon, than to listen to the discourse; and, having 'fixed' upon him, to make him turn his head in your direction.

* * * * *

" The writer and his sister have breakfast together almost daily, and have, during that meal, almost daily experiences of 'simultaneously' mentioning either the same event or the same person.

" Our mother, who was an invalid for some ten years, and was practically in her bedroom for the whole of the time, had, by some means or other, the appearance of 'knowing' what was going on around her without any possibility of having been 'informed.'

* * * * *

" On one occasion, in particular, we had notice to quit the house we were then living in. The notice was served, by post, in the morning; but in the afternoon—much to my sister's surprise—my mother said to her, 'As we *have* to leave this house, I shall not be sorry—it will be a change.' Her hearing was defective, and her room was too far away for her to have heard any conversation in relation to the notice, and, fearing to trouble her, the notice had not been mentioned to her, or spoken of in her presence.

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" The writer only gives these personal experiences as interesting parallels with the doings of 'Mr. X,' but, interesting though they may be, he still thinks that Bacon was not far wrong when he said:

" 'The human intellect, in those things which have once pleased it (either because those have been received and believed, or because they delight), draws also all other things to vote with and consent to those—and though the weight and multitude of contrary instances be the greater, yet either it does not observe them, or despises them, or draws distinctions, and so removes and rejects them—not without great and pernicious prejudice—in order that the authority of those previous conclusions may remain unshaken. And so he answered well, who, when the picture of those who had fulfilled their vows after escaping the peril of shipwreck were shown to him hung up in a temple, and he was pressed with the question, did he not after this acknowledge the Providence of the Gods, asked in his turn, " But where are they painted who, after vowing, perished? " The same is the method of almost every superstition, as in astrology, in dreams, omens, judgments, and the like: in which men who take pleasure in such vanities as these attend to the event when it is a fulfilment: but where they fail (though it be much the more [illegible], there they neglect the instance and pass it by.'[1]"

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We have to offer our warmest congratulations to two of our contributors—Mr. W. L. Bragg, Professor of Physics in the University of Manchester, and Dr. A. H. Church, Lecturer in Botany in the University of Oxford—on being recommended recently for election into one of the goodliest fellowships on earth, that of the Royal Society.

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Last month, by an oversight, I omitted to thank Prof. J. L. Myres, of New College, Oxford, for kindly lending me the three photographs of Greece which illustrated Prof. Halliday's article.

Vitamines, or Accessory Food Factors

By James England

In 1897, C. Eijkman, who was the medical officer of a prison in Java, found that the fowls belonging to the establishment showed symptoms of paralysis and died, with extensive degeneration of the peripheral nerves. These symptoms were strongly suggestive of the disease beri-beri, then prevalent among the patients of the institution, and, as the fowls were mainly fed upon the rice refuse of the establishment, a dietetic origin for the disorder in fowls and men was suggested.

For a long time it had been considered probable that some connection existed between the human disease beri-beri and a rice diet, although it was not prevalent among all the native tribes who subsisted principally upon that food. Investigations showed that those affected consumed what is known as "polished" rice. This consists of the grain steam-milled, whereby the outer skin is removed, and polished with talc between sheepskins. The process does not injure the rice as a diet, but removes the cuticle, or skin, and the germ, or embryo. In districts where these constituents are retained, or where domestic or native mills are used, thus rendering their separation much less complete, beri-beri does not occur.

Eijkman supplied his fowls with an aqueous extract of the skin and embryo of rice removed in the process of milling, and quickly effected a cure. He called this disease *polyneuritis gallinarum*, and further study of it established its physiological equivalence to human beri-beri.

It is now fairly conclusively proved that the disease can be prevented or cured in man by substituting whole rice, or that prepared in native mills, for the "polished" article.

In those days, disease was generally ascribed to positive agents, such as microbes, toxins, or other poisons. In cases where a deficiency of a food constituent, or an internal secretion, was indicated, the disease was ascribed to the absence of a corrective to deleterious conditions or substances. It is, therefore, not surprising that Eijkman should have suggested that the skin or pericarp and the embryo of the rice were necessary to neutralise the otherwise deleterious effect of a diet overrich in starch.

This theory of Eijkman's did little more than add to the list of substances which at that time were considered necessary for the proper nutrition of animals, including men. But Captain Cook, about the middle of the eighteenth century, was nearer to modern developments when he stated that fresh food, especially green vegetables, contained *something necessary to maintain health*, which was absent from the preserved food used during his voyages.

It has been for some time a fairly well accepted principle, even outside the medical profession, that the substances necessary for proper nutrition comprise proteins, fats, carbohydrates, and certain minerals. But Captain Cook's "something" has recently been proved to be necessary also.

Proteins are described by the chemist Victor von Richter as rather enigmatical bodies. They are entirely of organic origin—that is, derived by the agency of life—and form the principal constituents of the animal organism. They also occur in plants, chiefly in the seed, and in the gluten of wheat, the albumen or white of egg, and certain constituents of the yolk, of milk, and of blood.

Carbohydrates include such substances as sugars, gums, starches, and cellulose.

Fats include such substances as butter, cream, and many of those pieces of meat which the ordinary child usually puts on the edge of the plate as unpalatable.

Minerals necessary as food comprise common salt, and compounds containing phosphorus, iron, and calcium, with a few others in very small proportions.

It will be seen from these descriptions that the substances previously considered to be the sole necessaries are the principal constituents of human food, while the requisite proportions are generally maintained by the variety ingested. A deficiency of any of them was considered to be conducive to what is known as "deficiency diseases"—such, for instance, as scurvy, rickets, etc.—but it is probable that the diseases are more often

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[1] Bacon, *Novum Organum*, Lib. I, Art. 46 (Kitchin's Translation).

—if not always—caused by a deficiency of that "something" which is now known as accessory food factors, or vitamines.

In 1881 Lunin stated that, in addition to the dietary units recognised at that time, other substances existed which were equally indispensable for life.

In 1906 F. G. Hopkins, Professor of Biochemistry in the University of Cambridge, wrote: "No animal can live upon a mixture of pure protein, fat, and carbohydrate, and even when the necessary inorganic material is carefully supplied, the animal still cannot flourish. The animal body is adjusted to live either upon plant tissue or other animals, and these contain countless substances other than the proteins, carbohydrates, and fats."

It was, however, not until early in 1914 that Casimir Funk issued a detailed and authoritative account of some newly discovered bodies, which he named vitamines, on the erroneous supposition that they were chemically related to ammonia, as indicated by the suffix "-amines." These bodies were stated to be necessary for the growth and preservation of life.

It is at present generally accepted that there are three distinct vitamines, or accessory food factors, as they are more correctly named. They are:

1. The Fat-soluble A or Antirachitic Factor.
2. The Water-soluble B or Antineuritic (Anti-beri-beri) Factor.
3. The Antiscorbutic Factor.

Their chemical constitution is at present unknown; but Funk, by chemical processes, obtained a crystalline substance melting at 233° C., for which he obtained the formula $C_{17}H_{20}O_7N_2$, while Hofmeister claims to have separated a vitamine of the formula $C_5H_{11}NO_2$. J. C. Drummond, however, suggests that, owing to the facility with which vitamines are "adsorbed," they may have been carried down by other precipitates in the process of their isolation and examined and estimated as such.

Notwithstanding the present ignorance respecting their chemical nature, a vast amount of work of an empirical, but none the less conclusive, character has been carried out. These experiments, performed on young and growing animals, were generally of a preventive or of a promotive character, followed by curative measures. In both cases the animals were fed with food well balanced in respect of proteins, etc., but from which vitamines were absent. In the one case preparations containing vitamines were supplied with the food, while in the other case the food was not so supplemented until a cure was thought necessary. The result of these experiments was that, in the absence of vitamines, the animals under experiment suffered from "deficiency diseases" and ultimately died, unless the vitamine preparation was administered in time, when a speedy cure was usually effected. The application of these results to human beings is based on the assumption that the causes of failure of nutrition of one kind of mammal would produce untoward results of some kind in other mammals, and most probably the results would differ only in degree. In this way, many foods were approximately standardised in respect of their vitamine or accessory factor content.

The following table indicates the values obtained in respect of a few substances:

Foodstuff.	A.	B.	C.
Butter, cod-liver oil	+++	o	
Cream, mutton and beef fat or suet, fish oil	++		
Lard, vegetable oils	o		
Lean meat (beef, mutton, etc.)	+	+	+
Liver	++	++	+
Kidney, heart	++	+	
Brain, sweetbreads	+	++	
Fish (white)	o	?	
„ (fat), salmon, herring, etc.	++	?	
„ roe	+	++	
Tinned meats	?	V.S.	o
Milk, cow's, whole raw	++	+	+
„ „ skimmed	o	+	+
„ „ dried whole	+	+	V.S.
„ „ boiled		+	V.S.
Cheese, whole-milk	+		
„ skimmed-milk	o		
Eggs, fresh and dried	++	+++	?
Wheat, whole-grain, other cereals generally	+	+	o
White wheaten flour, cornflour, polished rice	o	o	o
Germinated pulses and cereals	+	++	++
Cabbage, fresh, raw	++	+	+++
„ „ cooked		+	+
Potatoes, raw	+	+	
„ cooked			+
Orange juice, fresh; swede, raw, expressed juice; lemon juice, fresh			+++
Lemon juice, preserved; lime juice, fresh			++
Lime juice preserved			V.S.
Vegetables and fruit generally	+	+	+
Yeast	?	+++	o
Meat extract	o	o	o
Beer		o	o
Honey		+	

A represents the Fat-soluble A or Antirachitic Factor.

B represents the Water-soluble B or Antineuritic (Anti-beri-beri) Factor.

C represents the Antiscorbutic Factor.

+, ++, +++ indicate the relative presence of the factor in three degrees.

o indicates their absence.

? indicates doubt as to their presence.

V.S. indicates a very slight quantity, less than +.

Where no indication is given in the various columns, no estimation was made.

Note.—The information in this table is extracted by permission of the Medical Research Committee from a more extensive list in the Report mentioned at the end of this article.

It may be accepted as a general statement that fresh animal and vegetable food, before treatment of any kind—but including butter and whole-milk cheese—usually contains the fat-soluble A and water-soluble B factors, while the antiscorbutic factor is not quite so generally or abundantly present, except in the juice of many kinds of fresh fruit and in cabbage. Potatoes form one of the cheapest and most practical sources of vitamines.

In the present stage of the theory very many more or less conflicting opinions have been expressed respecting vitamines and their susceptibility to change or destruction under varying conditions, so that it is probably unwise to generalise. It may, however, be safely inferred from the table of results that fresh food in its natural condition is more conducive to growth and health than the manufactured and ofttimes sophisticated article, however palatable it may be. Further, that excessive cooking is prejudicial to the vitamine-content of the food, since vitamines are somewhat readily destroyed at temperatures above 100° C., especially in alkaline reactions. It also appears from experiments that free oxidation during heating is conducive to their destruction. They are more stable in acid mediums, hence the value of lemon juice, oranges, and many other fruits.

It would appear as though nature had furnished human beings with an appetite instinctive for food containing the full complement of vitamines, and that civilisation has been doing her best to eradicate that instinct, to the detriment of the human race. And if instinct, operating through the taste, means anything in respect of food, it surely should be considered, in the natural and healthy individual, as prompting a selective action for those kinds which contain the special factors provided by nature for growth and health.

Moreover, the theory confirms certain prevalent dietetic principles. It does not depose cod-liver oil, fresh fruit, green vegetables, milk, or fresh meat. It certainly advocates less highly cooked food, and in that respect it is supported by dentists, who refer the modern inferiority of teeth to their diminished use on account of the highly cooked—and therefore softer—condition of present-day food.

In one direction it does certainly advocate a complete revolution, and that is in the case of cereals. It is not the first time that wholemeal bread has been advocated, but what was little more than a predilection before is now supported by a well-founded theory.

A short description of the various parts of a grain of wheat may perhaps serve to remove the odium attaching to wholemeal flour and bread created by the unfortunate use of the word "offal" in connection with those portions of the wheat rejected during milling. At the same time, it may afford some insight into the structure of cereals generally.

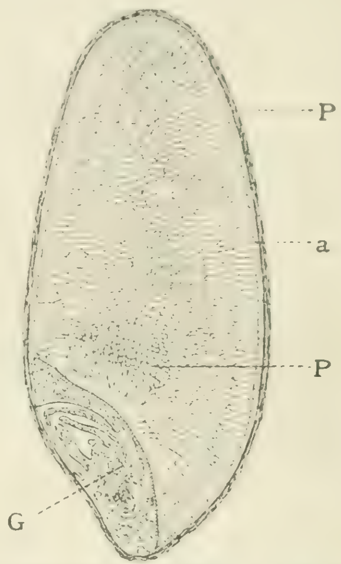


FIG. 1.—LONGITUDINAL SECTION THROUGH A WHEAT GRAIN. FOR SIMPLICITY, THE CREASE IS NOT INDICATED

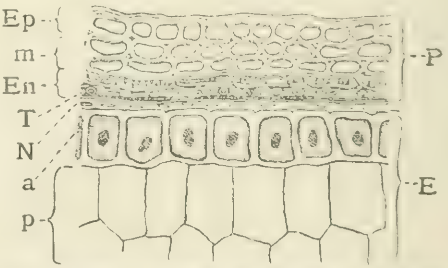


FIG. 2. CROSS-SECTION THROUGH THE BRANNY ENVELOPE AND OUTER PORTION OF THE ENDOSPERM OF THE GRAIN MAGNIFIED ABOUT 150 TIMES.

The references for both figures are:

P. Pericarp forming with (T) the testa and (N) the nucellus the branny envelope of the grain, and comprising:

ep. Epicarp; *m.* Mesocarp; *en.* Endocarp.

N. Nucellus.

T. Testa.

E. Endosperm, comprising:

a. Aleurone cells; *p.* Parenchymatous cells.

G. Germ or embryo.

As indicated by the diagrams, the grain is surrounded by a series of tough cellular envelopes, which are removed by the miller as completely as possible to produce the whitest or "patent" grade flour. This grade therefore consists principally of the milled parenchymatous cells (*p*) of the endosperm. The other grades of flour contain varying proportions of the skins of the grain and the germ, with wholemeal flour at the other end of the grading, which should contain the entire grain with the germ. The germ is the richest in vitamines, and is said to impart a pleasant, nutty flavour to bread. The aleurone layer is the next in importance as regards vitamine-content.

From what has been mentioned about underdone food, it might be inferred that, in the process of baking, the vitamines in wholemeal dough would be destroyed by heat in the oven. Such is, probably, the case to some extent, but it is also probable that the crust towards the end of the process forms a protective coating which keeps the interior moist, and thus prevents any serious rise in temperature above 100° C., even if it attains to that degree. There is little doubt that in these circumstances some proportion of the vitamines is preserved. In domestic cookery it is probable that a larger proportion remains intact.

As long ago as 1911, Dr. J. M. Hamil reported to the Local Government Board that in bread made from the "entire" wheat class "the presence of the offal, including the germ, secures a somewhat larger quantity of mineral matter and of suitably combined phosphorus or *other substances*, as yet unknown, which may prove to be of importance." The italics are not used in Dr. Hamil's report. In order that no misunderstanding should arise respecting the mineral matter and combined phosphorus, he states that they "possibly may be necessary for health" in the case of children. It is probable that they are necessary for adults also ; at any rate, there is nothing about them that suggests "offal" in the usual meaning of the word, since, comparatively, they largely enter into the composition of many foodstuffs.

There are, however, serious, but not insurmountable, objections to the use of wholemeal flour. It is stated by millers that the germ adversely affects the keeping qualities of flour ; but the modern methods of milling and the use of sound grain probably synchronise with the improved keeping qualities of flour nowadays, and thus remove any blame from the germ as affecting keeping qualities. Experiments indicate that wholemeal flour remains in good condition if the moisture be not excessive.

The baker states that the germ in flour affects the strength and stability of the dough, while wholemeal flour absorbs less water and does not produce such a large loaf or such white bread as the highest grades of flour. The quality of the dough could no doubt be improved if necessary, as a result of research into the matter, or even by the omission of one or more of the other ingredients usually introduced by the baker. The absorption of water and the size of the loaf are probably inconsiderable factors, except from the point of view of the baker, who would eventually find means of recouping himself for any loss occasioned by the use of wholemeal flour. But colour is everything ! It is respect for that quality which induces people to use bicarbonate of soda in cooking greens, and thereby reduce the vitamine-content of an ample and economical supply. For this reason, all kinds of sophistication of food are condoned, even the use of poisonous sulphate of copper used in preserved green peas. The objections to wholemeal bread, on account of a growing appreciation for science, may eventually be removed, and its superior dietetic qualities be recognised with beneficial results.

On account of our ignorance of the chemistry of vitamines, they have not yet been successfully isolated ; therefore, neither their constitution nor their appearance is known. It is no very extravagant thought to visualise them as the connecting-link between inanimate and living matter ; but at present it would appear from tentative attempts at their isolation that they, or their compounds, are crystallisable bodies.

It has been proved by experiment that they are indispensable to life, and no diet is complete without them. In their continued absence, the muscles eventually dwindle, the nerves degenerate, heart and bone become affected, and a predisposition to tuberculosis subvenes.

They are believed to be solely manufactured by vegetable life, whence they pass into animals. Although not credited with nutritive qualities themselves, there is strong evidence of their decomposition, or of change in their constitution in the animal system, on account of their continuous supply being necessary for the proper nourishment of the body by the food ingested. Funk regards them as the mother substance of ferments and hormones, and of vital importance to the thyroid and other ductless glands. It has also been advanced that their action is catalytic—that is, that they induce the change in the food necessary for its proper assimilation, without themselves undergoing change. Although theoretically a catalyst is unaffected by the reaction it induces, yet, on account of the almost unpreventable presence of foreign bodies or impurities, in most cases other reactions take place during catalysis, and thus modify the catalyst itself. On this account, its action is hindered and finally arrested. Such is very probably the action of vitamines in animal systems, and thus their constant renewal is necessary. This is all the more probable because, when animals are deprived of vitamines, the progress of their disorder is very slow at first, with later acceleration, and their recovery rapidly follows the administration of the accessory food factors.

On account of their infinitely small proportions in food, it is no matter for surprise that vitamines have so long eluded the vigilance of the chemist during researches in connection with food. As a contrast to the vast magnitudes forced upon our consideration during the war, and since then—even painfully—by the Chancellor of the Exchequer, Science has been teaching the importance of the infinitely small; and when one considers the enormous injury that a few imperceptible microbes can effect in the human system, it is but reasonable to acknowledge that an equally small or slightly greater quantity of a substance may be not only beneficial, but absolutely necessary to health.

NOTE.—It has been possible to give no more than a very brief outline of the subject here, but for those desirous of proceeding further the *Report on the Present State of Knowledge concerning Accessory Food Factors* (*Vitamines*) to the Medical Research Committee, Special Report Series No. 38, published by H.M. Stationery Office, 1919, price 4*s*., can be thoroughly recommended. The book—unlike most Government publications—is quite understandable, since it is written in a lucid style, with few technicalities. It also contains a long list of other important publications on the subject which would prove invaluable to the student. More recently a discussion of the subject was published in the *British Medical Journal* for July 31, 1920, price 6*d*.; and Dr. J. M. Hamil's *Report to the Local Government Board on the Nutritive Value of Bread made from Different Varieties of Wheat Flour* (H.M. Stationery Office, 1911, price 3*d*.), although not dealing with accessory food factors, affords useful information in connection therewith.

The Undiscovered North

By J. M. Wordie, M.A.

St. John's College, Cambridge

THE Arctic problem of most moment to mankind has never been the actual reaching of the Pole itself. The objective of the early explorers was a practical one—the investigation of a North-West Passage to China: when that was found impracticable, scientifically-directed exploration would have turned its attention to the possibility of discovering new land in the unexplored Polar Basin. Both the "man in the street," who supplied the weight of public opinion, and the wealthy supporter, who has so often supplied the necessary funds, which have respectively made public and private exploration possible, have, however, had their minds and imaginations filled rather with the idea of planting a national flag at the summit of the earth. It is through this fact that at the present day modern geographers are disgraced by the continued existence of a huge unexplored tract about the North Pole, which may or may not contain notable land areas.

The Pole itself, not quite in the centre of that basin, has probably been reached—by Cook or by Peary, or by both; though the possibility still remains that neither actually reached the goal. Whatever be the truth, the results of these two expeditions are equally meagre and valueless: it is quite clear that neither Peary nor Cook were scientific observers either by instinct or by training. In this respect they compare most unfavourably, for instance, with Captain Scott in the Antarctic and the long list of British naval officers who explored Arctic Canada in the fifties of last century. The bitter controversy between Cook and Peary, the natural aversion thus engendered, and the poorness of their results are in marked contrast to the popular applause which greeted Shackleton back from the Antarctic about the same time with results and observations exceptional both in quantity and in quality. For these and other reasons the public of to-day regards the Antarctic rather than the Arctic as the explorers' main field. In the last generation only one British expedition, the Canadian Arctic Expedition under Stefansson, has tried to penetrate the unknown Arctic, whilst since 1900 hardly a year has gone by without one or more parties wintering in the Antarctic.

Yet in the Arctic, as much as in the Antarctic, a really big discovery may be made. There is still a possibility of finding a new land, perhaps as big as Britain, in or near that part of the Arctic Ocean called the Beaufort Sea. Whoever is fortunate enough to find such a land-mass will have made the last great Arctic discovery.

The arguments for and against the occurrence of land are many and evidence of many descriptions has been cited on either side; but, as has so often been the case in other geographical problems, most of the deductions put forward have little real weight. Appeal, for instance, is made to legends of Alaskan Eskimo about land to the north; but who can tell whether these stories have originated where the Eskimo now live or whether they were brought by their ancestors from elsewhere? Flights of birds are constantly seen going north from the Alaskan coast, and these migrations may have a little more value; on the other hand, it is quite possible that their objective is simply some portion of the Parry Archipelago. Then there have been from time to time definite statements made by whalers and explorers to the effect that they have actually seen land; these, however, have not so far survived further investigation: notable examples were the so-called "Crocker Land," which MacMillan wiped off the map in 1914, and "Keenan Land," dealt with in similar fashion by Storkersen in 1918.

Reasons based on the nature of the pack-ice found round the margins of the unexplored area cannot be dismissed quite so easily. Yet there is perhaps no more unsound argument; for heavy pack is used by the protagonist of one party (MacMillan) as practically proving obstructing land, while other authorities (e.g. Nansen) draw from it an exactly opposite conclusion. In this connection, it should be stated that there is no more untrustworthy guide to the nature of the pack-ice than the popular accounts of the expeditions sent out to search for Sir John Franklin: travellers' tales are a byword, and have certainly lived up to their reputation in the matter of pack-ice. Matters were also made worse through members of the Nares Expedition of 1875 arguing for a "palæocrystic sea" of unknown antiquity. Few reliable records, in fact, of the thickness of the ice exist before the development of the camera and its application to Arctic work provided a method of standardisation which, when used scientifically as opposed to artistically, does not lie. To-day no one believes in a "palæocrystic sea"; and any scientist wishing to argue about the Arctic pack can refer to Nansen's *Farthest North*, where he will find that the heaviest normal ice the latter met with is not more than five years old. Nansen qualifies his statement by limiting its application to the ice found along the *Fram* track. The fact is probably, however, of universal application: for none of the photographs accompanying MacMillan's, Stefansson's and Storkersen's articles show anything widely different from the five-year Arctic floes or even from the two- to three-year Antarctic pack.

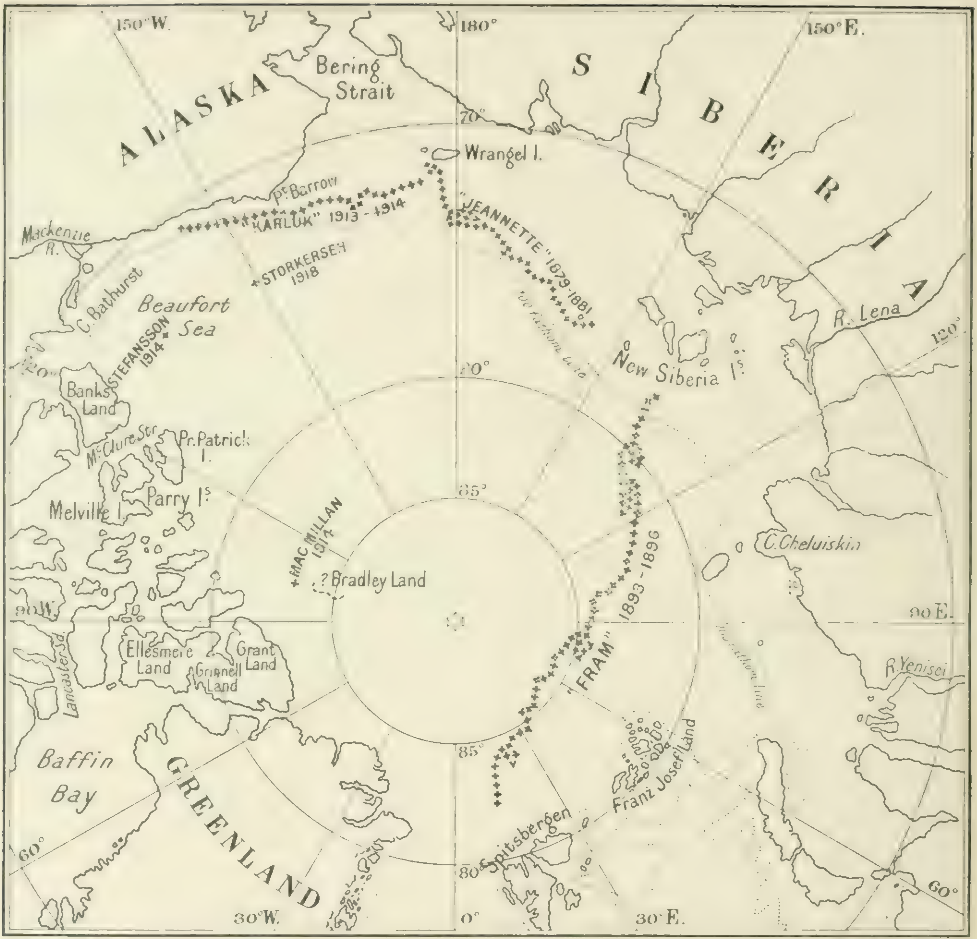
Nansen has not only shattered theories built on the nature of the ice, but has also invalidated to a great extent those built on tidal and current phenomena, which are by some regarded as still more convincing. One writer in America, basing his hypothesis on oceanographical grounds, has even drawn a map with the supposed land marked in. Exploration since then has only touched the fringe of the debatable area, snipping off small pieces from the margin of this hypothetical polar land. Nansen, however, strikes at the very heart of the theory, pointing out most forcibly that the present tidal observations are contradictory; they are therefore quite useless for arriving at any such general conclusion, and likely to be misleading if so employed.

There are, in fact, only two lines of evidence which are in any way reliable. The first of these is the position of the edge of the so-called continental shelf; the other is based on the drifts of various ships caught in the ice. The edge of the continental shelf is taken as the 100-fathom contour of the sea bottom. It is found in practice that this line approximately encloses a wide area of shallow water round all the continents, and that the transition from this to oceanic depths is a sudden one. Known Arctic lands are all situated on a shelf of this nature; and beyond it Nansen has proved the existence of depths of over 1,000 fathoms, which probably prevail over a large part of the Polar Basin. With the exception of a few isolated islands of volcanic and coral origin in the southern seas, it is contrary to all experience to find lands arising from oceanic depths. One can therefore say that, if the boundary of the continental shelf were completely known round the Arctic Ocean, it would be quite justifiable to infer that there was no large mass of undiscovered land in the Polar Basin. This, however, is very far from being the state of our knowledge. On the accompanying sketch-map a dotted line shows roughly the 100-fathom limit north of Alaska and Siberia. It is based on a relatively small number of observations, and it is quite likely that subsequent exploration will cause big corrections to be made to it. North of the Beaufort Sea, however, there are no observations at all, and it is just here, where the position of the outer edge of the continental shelf is unknown, that land may exist.

The drifts of vessels in the ice supply very positive information. The *Karluk* (1913–14), *Jeannette* (1879–81) and *Fram* (1893–96) tracks are almost a continuation one of another. They do not represent so much the route of a true current as the mean wind directions from point to point; and, moreover, the ice does not drift directly before the wind, but 15°–20° to the right. They show, in fact, a wind-drift which can be paralleled in all the other oceans. It is surely a stroke of good fortune that the only three drifts on record should link up one with another to form an almost continuous curve round the unexplored area. It goes without saying that, given the continuance of present meteorological conditions, any other ships will be certain to follow more or less closely this extraordinary line.

An interesting piece of evidence in connection with the above is afforded by the drift of some of a large number of casks which were placed on the ice north of Canada and Alaska twenty years ago. Of these only two have yet been located, one of them having travelled from Point Barrow to Iceland in six years, the other from Point Bathurst to the north of Norway in eight years. Very likely both followed the *Karluk-Jeannette-Fram* track: the first, however, did not travel down the Greenland coast to Cape Farewell, as did the *Jeannette* wreckage, but, being farther off the coast, was deflected to Iceland; the second was presumably also somewhere near Iceland when it got caught in the Gulf Stream Drift and carried north again to the north of Norway.

The East Greenland Current is a continuation of the Arctic Drift, but its rate is three to four times as fast as the movement of the ice in the Polar Basin, where the



rate found by Nansen averaged about one mile per day. The relation between the Greenland Current and the Polar Basin is therefore similar to that between a mill-race and a sluggish pond which it drains. To keep the race fed a big gathering-ground is necessary: and it is therefore a fair deduction that the bigger part of the unexplored area is likely to be ice-covered sea.

This is the state of knowledge about the Polar Basin; and sporadic attempts have already been made to find the new land. To Mikkelsen and Leffingwell belongs the credit of first venturing out (in 1907) from the Alaskan coast on to the polar ice, though their journey was hardly long enough to give definite results. Stefansson's wonderful trip from Martin Point in Alaska to Banks Land in 1914 was a much longer journey, but is just as inconclusive. On the information gained, however, he arranged for one of his men, Storkersen, to make a still longer trip. Storkersen sledged out about 150 miles from the Alaskan coast in April 1918; and then lived on a drifting floe for six months. His observations show that there is little or no true current: the wind is the controlling factor, and under its influence he zigzagged back and forwards for a long time over the same ground, just as did the *Jeannette* and the *Fram* during their drifts. Then, unfortunately, before any conclusion could be arrived at as to the direction of the drift, Storkersen had to return owing to ill-health. Among other things, however, he brought back a large number of reliable soundings, and once and for all removed the so-called "Keenan Land" from the map. Incidentally Stefansson and Storkersen made one very notable discovery, namely, that it is possible to "live on the land" even on the drifting pack-ice—at least in the Beaufort Sea area.

One other expedition on to the polar pack deserves mention, namely MacMillan's journey in 1914 to try to find "Crocker Land"; he travelled at a surprisingly good rate over the ice, and very soon proved that there was no "Crocker Land." Then, probably owing to dog trouble, he turned back, when to all appearance he had a clear field either to go right ahead, or else, by turning in a more northerly direction, to verify or disprove the existence of Dr. Cook's "Bradley Land" in 84°–85° N.

Neither soundings nor the drift of ships, nor the reports of travellers on the pack-ice, show evidence against possible land north-west of the Parry Archipelago. On the whole the balance of evidence, particularly the big feeding-ground necessary to supply the ice carried by the Greenland Current, suggests that the land, if present, is not of very large size. Like many another problem, the only practicable method of solution is to "Go and see." This is what Amundsen is doing at the present time: for he hopes to drift across the Polar Basin in the same way as the *Fram*, but in higher latitudes, that is to say nearer the Pole. In the last telegram received (dated August 1920) he was forging into the pack north of Bering Strait, but with a crew of only four men all told. Should he get well within the *Karluk-Jeannette* track, the chances are that he will finally drift very close to the Pole itself. Ships have indeed sailed as far north in this quarter as approximately 74° N. It is much more likely, however, that he will be caught in the ice and start drifting before a really high latitude is reached. In that event new geographical results will only be obtainable if he leaves his ship, a course the small size of his crew is likely to prevent him from adopting, unless the ship is crushed and he has to leave it perforce. If the latter situation should arise, it is to be hoped that he will be able to sledge across to Grant Land (where a depot of provisions has been laid for him) either via the Pole itself or via "Bradley Land." Of the two journeys the latter is the more desirable from the geographical point of view. The existence or non-existence of "Bradley Land" is the touchstone for testing Dr. Cook's claims to have reached the North Pole. If land does not exist, his case is demolished for ever. A photograph of what is undoubtedly high mountainous land is given in Dr. Cook's book and is labelled "Bradley Land"; and the letterpress is equally unambiguous. Judgment on Cook should therefore be reserved till his statements have been confirmed or refuted.

It may be said, perhaps, that the search for new land north of the Beaufort Sea might well be held over until Amundsen returns. This is not so; Amundsen's track cannot pass anywhere near the one likely area where the edge of the continental shelf is neither known nor to be inferred with any certainty. The chances of making a successful attack may be considered as good. Ships have reached both Banks Island and Melville Island, though neither of these is quite near enough to the final objective. An effort should be made to reach Prince Patrick Island in a motor sloop of 50–100 tons; Winter Harbour on Melville Island was not difficult to reach from Baffin Bay a century ago under sail alone; surely ships of to-day can better that record? If the sloop gets held up, a whaleboat or cutter should be able to reach and establish a base even on Prince Patrick Island. The latter is the ideal jumping-off ground for a sledge journey north-westwards for 400–500 miles, a journey which will either result in the location of new land or settle finally the last important Arctic problem.

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Maritime Wireless

By Lieut.-Col. C. G. Crawley, M.I.E.E.

THE first, and still by far the most important, application of wireless signalling was for communication with ships; in fact, even yet there are no regulations governing international wireless working except those contained in the International Radiotelegraph Convention of 1912, which deals only with ship communications.

So far as these communications are concerned, the wireless telephone is in no greater use to-day than it was nine years ago; but in the case of aircraft it forms the principal means of communication with the ground, and between the aircraft themselves. This is largely due to the fact that most aircraft can ill afford to carry a trained telegraphist to do work which can be done, though on a more limited scale, by the pilot himself making use of a wireless telephone.

Before long, no doubt, the wireless telephone will come into more extensive use for maritime communications, but for some time to come it is likely to remain as much a luxury for ships as the telegraph is for aircraft. The great advantage of the telegraph over the telephone is that much longer ranges can be obtained for the same expenditure of electrical energy, and the great disadvantage is that a telegraphist is required to work the apparatus, though it must be remembered that even the operation of a wireless telephone requires a certain amount of training. There is an obvious future for telephony in ships when arrangements can be made for communication through land stations direct with subscribers on the telephone system of the country; but we had better confine ourselves to the present time, when, as a matter of fact, such arrangements are not in operation, and wireless telephony is not used for ship and shore communications. On the other hand, wireless telegraphy is now universally recognised as an essential fitting for the safety of life at sea, and in this country has recently been made compulsory for all sea-going ships which are passenger steamers, or ships of 1,600 tons gross tonnage or upwards. This includes over 3,000 British ships. In vessels carrying 200 or more persons, three operators are normally carried, and a continuous watch is kept. In those with 50 to 200 persons, continuous watch is also kept, one operator and at least two "watchers" being carried; and in the remaining ships watch is kept for eight hours daily at specified times, one operator only being carried. The qualifications required in the case of a watcher are such as to ensure his recognising the general distress call and the safety signal. Should he hear either of these calls, he turns over the watch to a skilled operator. Any person in the ship, if so qualified, may act as a watcher.

In this country the Post Office issues licences to ships in respect of their installations, and certificates to operators and watchers who qualify at examinations conducted by that Department. The land stations for communication with ships (see map) are all worked by the Post Office, with the exception of the station at Poldhu, which is used partly for broadcasting Press and other messages to ships, that is, sending out messages without receiving replies. This station is worked by the Marconi Company. The station at Devizes is fitted with continuous wave apparatus, and communicates up to distances of about 1,000 miles, on a special wave-length of 2,100 metres, with such of the large liners as are similarly fitted in addition to their compulsorily-fitted installations. The other stations use spark apparatus similar to that compulsorily fitted in ships, and keep watch on the 600 metres wave, which is that used for distress messages and, in fact, for practically all messages sent by ships, with the exception of the long-distance traffic mentioned above. The compulsorily-fitted installation must be capable of communicating with a standard Post Office station up to at least 150 miles, but communication up to 200 or 300 miles is usually obtained according to the power of the installation fitted.

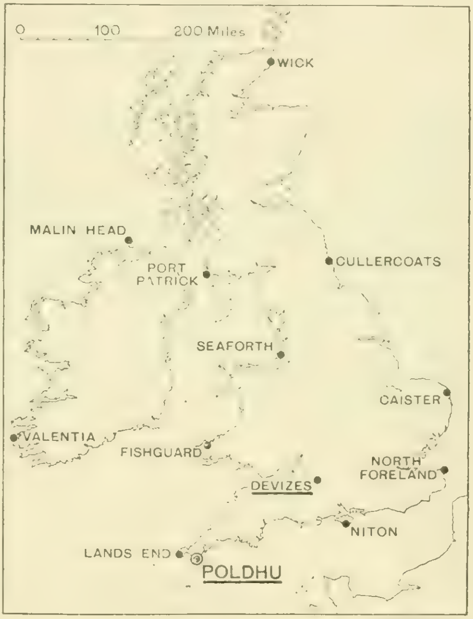
As a general rule, ships keep watch with their receiving apparatus adjusted for the reception of the 600 metres wave, and are thus ready to receive any message of distress from a ship within range or a call from a ship or land station. The wave-length of 600 metres was detailed for this purpose in the 1912 Convention, as it is a very suitable wave for transmission from ships of average size, and it was very necessary to lay down some one definite wave on which distress messages would be sent, and would have as good a chance as possible of being received by all ships and land stations within range. A distress message is preceded by a signal consisting of three dots, three dashes, and three dots sent as one sign, and repeated at short intervals. This is usually alluded to as the S.O.S. signal, though the letters S.O.S. sent as a group in the Morse Code is not really the same as the distress signal which is sent as one sign. When this signal is received all communication ceases, except that consequent upon the call for help. The safety signal consists of three dashes repeated ten times at short intervals, and is sent as a preliminary to information of an urgent character involving the safety of navigation, e.g. icebergs, derelicts, cyclones, etc. The idea of adopting some such warning signal resulted from the inquiry into the loss of the liner *Titanic*, which struck an iceberg and sank on April 15, 1912. In this case the S.O.S. signal was responsible for saving over 700 lives, and if a safety signal had been in general use, it is quite likely that the whole terrible disaster would never have occurred.

It is hoped that before long satisfactory automatic apparatus for registering the distress signal will be devised, in which case it is laid down that British ships, now only compelled to carry one operator, shall also be fitted with this apparatus, and ships which carry watchers as well as an operator may substitute the apparatus for the watchers.

The international regulations framed at the 1912 Convention for maritime wireless signalling are still in force, but are in much need of the revision which normally would have taken place three years ago, and which it is hoped may be arranged for this year, as the great strides made in wireless practice during the war have naturally overstepped the somewhat restricted boundaries of the Convention.

As a matter of fact, the apparatus used in merchant ships was much the same at the end of the war as at the beginning. All the great developments had taken place in naval, military, and air force stations, both mobile and fixed, and little time was left for improving the design of apparatus for the mercantile marine. As soon as the war was over, however, the technical lessons gained were quickly applied to the design of ships' sets. Old sets have now been overhauled, and when new ones are installed, their all-round efficiency is far in advance of the pre-war type. In many of the larger passenger steamers a long-range set, using either the Valve or the Arc System, is being fitted, in addition to the Spark set, and altogether the technical arrangements are rapidly being brought into line with the improvements made in the naval ship sets during the war. Many naval requirements are, of course, not applicable to the mercantile marine; in fact, the technical lines of development in the two services can never run on exactly parallel lines, as a warship is normally required to fit in for communication purposes with a fleet in close touch, several ships of which may be signalling simultaneously on different wave-lengths; whereas a merchant ship is normally acting as a more or less isolated unit, always ready to receive a distress call on the 600 metres wave-length from any ship at extreme range. This means that for a warship very selective apparatus is an absolute essential, and it can be readily arranged, as a navy is a small unit where control is easy; but in the merchant service great selectivity may often be a distinct disadvantage, as calls from ships not accurately adjusted to the wave-length intended may be missed, and it is impossible at present to ensure that the apparatus in all ships of all nations shall be accurately adjusted. Selectivity, like Free Trade, is excellent if everyone else adopts it.

Besides long-distance continuous wave sets, with the possibility of telephony in the background, the important advent of directional apparatus must be noted. The wireless "direction finder" is becoming of recognised value in navigation when other means fail, as in fog. The apparatus is fitted in the wireless office and is worked by the wireless operator. With this apparatus the operator can obtain the bearing of a wireless station relative to the fore and aft line of the ship, and the actual position of the ship can be obtained by the intersection of bearings from two or more stations. Up to about 100 miles the bearings as set off on the Mercator's chart are accurate enough for all practical purposes, but for greater distances conversion tables or charts on the gnomonic projection must be used. In these charts great circles appear as straight lines instead of as curves, as in the case of Mercator's, and the fact that such charts are required for long distances will be evident when it is remembered that wireless waves travel along great circles over the surface of the globe. Usually the bearings obtained are correct within two degrees, and greater accuracy is not often required; but errors mostly due to the bending effects experienced by wireless waves, especially at night, do sometimes give trouble. A number of ships have been fitted with this direction-finding apparatus, and have often proved its utility as an aid to navigation in thick weather. There are some Government stations designed and used solely for the purpose of giving bearings to ships. In these cases the station takes a bearing by receiving signals transmitted from the ship, and communicates them to the ship. The results are as a rule more accurate than those obtained by having the directional apparatus in the ship; but the advantage of the ship itself being able to obtain its bearing from any ordinary station within range is so great that the present tendency seems to be to increase the number of ships fitted rather than the number of stations. Another advantage of having the apparatus on board is that in foggy weather it may be used for obtaining the direction of another ship fitted with wireless. Advances are also being made with directional transmission—that is, the transmission of wireless waves in one direction only, instead of the usual all-round radiation—an arrangement obviously of great value for navigational purposes.



It may be considered, therefore, that wireless in the mercantile marine, if it made no great technical advances in the war, is now progressing so rapidly that it will soon be as up-to-date in every respect as its supreme importance demands. For point-to-point communication there may be, and indeed there is, much discussion as to the relative merits of wireless and line working, but for ship and aircraft there can be no discussion: it is just wireless or nothing.

The Mooring and Handling of Airships on the Ground

By Major George Whale (Late R.A.F.)

THE accident to the rigid airship R34, which culminated in her total destruction on the night of January 29, has emphasised the necessity for providing more efficient methods of handling these large vessels on the ground and mooring them in the open.

It will be remembered that R34, although damaged in flight by striking a hill to the extent of disabling three out of five engines, arrived to all intents and purposes intact over the landing-ground of her base at Howden.

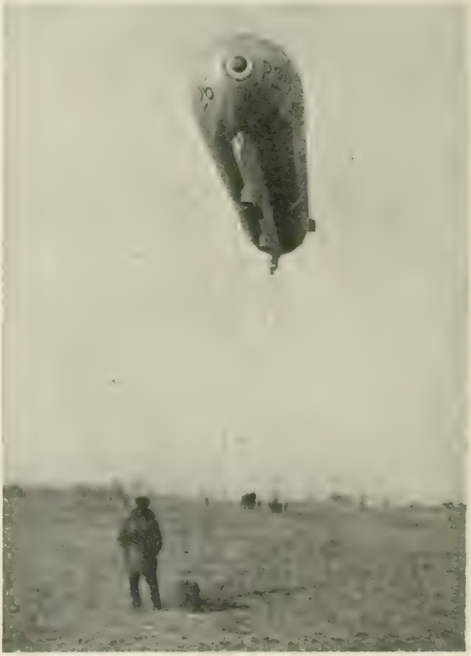
While attempting to take the ship into the shed under man-power, the initial serious damage was sustained by the forward car bumping on the ground. This was caused by the ship becoming unmanageable owing to the force of the wind. She was accordingly taken back to the landing-ground to be moored out by a method known as the three-wire system, which will be described in due course.* The forward part of the hull structure having sustained damage, the airship rode badly at her moorings, and threatened to break up. A second abortive attempt was made to enter the shed, which caused still further damage, and the ship afterwards became a complete wreck.

It is therefore apparent that man-power is insufficient to house a large airship in a shed under unfavourable weather conditions, and that the three-wire system of mooring is by no means to be depended on.

In this country, experiments have been conducted in towing airships by means of tractors to supplement man-power, but the results of these did not come up to expectations. In practice it was found that the tractors, owing to the uneven surface or slipperiness of the ground, advanced in a series of jerks, which imparted an uneven strain upon the towing cables. The tractors used—of which, perhaps, the army tank was found most suitable—were, admittedly, not designed for the work in hand.

The Germans, on the other hand, have made a standard practice of handling airships with the assistance of trollies and track rails, which, as far as can be ascertained, has proved highly satisfactory in their country.

The tracks, consisting of three rails each, are laid down through the shed and extend beyond for some considerable distance at either end. The two outer rails are flanged at the top and bottom and are set vertically, the centre one being laid horizontally. By this means the trollies are able to withstand both upward and lateral forces, which may be transmitted by the airship. The airship, having been landed as near to the rails as is possible, is "walked" by man-power towards the shed. When the forward part of the ship is over the rails, the handling guys are made fast to the trollies, when the towing process commences; as the after-part of the ship reaches the track, the same process is repeated, and the ship can be dragged into the shed by a very small number of men.



RIGID AIRSHIP MOORED OUT BY THREE WIRE SYSTEM. THE THREE MOORING CABLES ARE SHOWN, ALSO THE MOORING BOLLARD.

RIGID AIRSHIP R23 LEAVING SHED FOR TRIAL FLIGHT.

It is conceivable that, if the shed at Howden had been equipped with similar rails, R34 might have been housed without accident.

The difficulties attendant on taking airships in and out of sheds in any but favourable weather conditions are so great as to render this type of aircraft practically useless for commercial purposes, where a reasonable regularity of flying is essential, unless some means of overcoming them is assured. The solution of this problem is undoubtedly mooring in the open.

Since the early days of airship history, experiments have been conducted in mooring out as an emergency method in the event of mechanical breakdown preventing an airship from returning to her base. These experiments have throughout followed two lines of thought—(1) mooring by means of cables; (2) mooring to a mast.

With regard to the former of these two methods, in the early days trials were made in mooring to a drogue by a single cable over water. The dragging motion of the drogue through the water was found to check to a great extent any tendency of the bow of the ship to move in a lateral direction. When moored, however, to a single point on land, it was found almost impossible to keep the airship head to wind. To correct this tendency to surge, the method was amplified by introducing three cables, which were led to the mooring-point of the ship. This system, known in its earlier stages as the "Usborne Method," from the name of its originator, has been developed into the present-day three-wire system, which was utilised with unfortunate results in the case of R34.

In this system three bollards are spaced at a considerable distance apart, and form in plan an equilateral triangle. To these are attached the three mooring cables taken up by the lift of the ship, which floats in the air at the apex of the pyramid so formed. When trimmed up by the bow, the airship will be found to ride satisfactorily, although there is always a tendency to "yaw." The disadvantages of the method are the difficulty of replenishing gas in rough weather, and the danger aforementioned of the ship getting off the wind. For these reasons, mooring by cables can be considered only as an emergency method and not to be relied upon in commercial flying.

Various experiments have also been conducted throughout airship history with the mooring mast. At Farnborough, Kingsnorth, and Wormwood Scrubbs, masts of different designs were tried, and gave promise of better results in the future. Towards the end of 1917, most satisfactory trials were carried out with a new design of mast, using a small non-rigid airship. Encouraged by these, a large mast was designed and manufactured for the mooring of rigid airships. In this case the ship was secured by the extreme nose into a specially constructed socket at the head of the mast. The structure revolves on roller bearings, and as the ship is held rigidly, there is no danger of her " paying off " before the wind.

Gas and water trunks are led to the top of the mast, and from thence into the hull structure of the ship, with the result that the difficulty of regassing or refuelling is eliminated entirely. The trials which have been held up to date are eminently satisfactory, and are continuing at present at Pulham Airship Station with R33 and an improved type of mast.

There seems every reason to anticipate that the mast will be a complete solution of the mooring problem, and at the same time of regular flying of airships. In the future, the shed will be entered only on the occasion of periodical refits, as the surface vessel enters a dry dock.

In the days to come, we can envisage the mooring mast transformed into a mooring tower equipped with lifts for passengers and cargo. The giant air liner will pick up her moorings as easily as the Cunarder on entering port. Water, oil, and fuel will be pumped into the ship through mains incorporated in the tower.

The whole future of the airship is at stake on the efforts of the technical staff now working at Pulham. For this reason, it may be hoped that whole-hearted support will be forthcoming to assist in bringing its efforts to a satisfactory conclusion.

A Textbook of Inorganic Chemistry. By J. R. PARTINGTON, M.B.E., D.Sc. (Macmillan, 25*s.* net.)

A thoroughly good book for University men. The price, however, is high. It supersedes the existing textbooks of its class. Good diagrams and good printing. A number of slips have eluded the proof-reader. The parts of the subjects on which the author is an authority —Physical Chemistry, the Alkalies, etc.—are particularly well done. The idea adopted throughout of referring the atomic weights of elements to hydrogen as unity is a thoroughly bad one, and shows that the author does not appreciate recent work on radio-activity and on " isotopes." It should develop into a good second edition.

The Zeppelin Giant Monoplane

By E. Sinclair Puckett

ONE of the most curious results of the war was the almost complete disappearance of the monoplane. The writer saw only one solitary specimen during the latter half of the war, and that was a Fokker, a type that was used in the Near and Middle East at that time.

And yet, if one takes the four years immediately preceding the war, one finds that of 170 standard machines of all nationalities, no less than 108 were monoplanes.

Now that we are waging the fiercest peace on record, aeroplane design seems turning the other way, and the development of the monoplane as a commercial machine threatens to oust the biplane from its strong position.

There are several reasons for this, the chief one being economy. A monoplane is generally simpler to erect, rig, and repair ; and is very often cheaper to build. But most important of all, it can be flown at a moderate cruising speed and with considerable load, with a comparatively low-powered engine. This means considerably decreased petrol consumption and less initial cost of engine. This will be very much the case when high-lift wings of the newest type are in general use. An example of this is the " wooden " Fokker monoplane recently seen in this country. This machine carries six people at 80 miles an hour with a 180 h.p. engine. A single-engined biplane of a well-known cross-Channel type carries eight people at 120 miles an hour with a 450 h.p. engine, and the latter engine consumes probably five times the amount of petrol and oil that the former does.

High-lift wings are, of course, those that give the highest lift-drift ratio, or, in other words, those that give the greatest proportion of lift with the least resistance or obstruction to the air through which they pass. Racing machines have wings of minimum lift and small resistance to the air, that is to say, wings of flat, narrow section and small angle of incidence. High-lift wings are being mainly developed along three lines, represented by the German type wing and the British Alula and Handley-Page wings.

The German wing, with which we are concerned here, has very great camber (curvature), very great thickness, and a very full, round leading edge. This wing is found to give a very considerably improved lift.

But the most important development in modern aircraft is the construction of all-metal machines. This method of construction has been highly developed in Germany, where the celebrated Junkers' all-duralumin monoplanes have been much discussed for the past two years. The greatest achievement, however, in all-metal construction is the much talked of giant monoplane built in the Zeppelin works at Staaken.

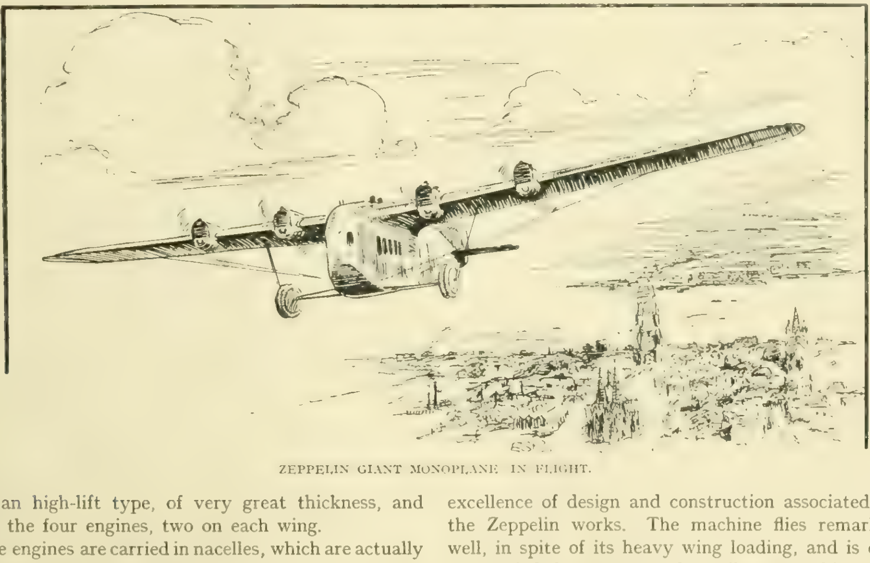
This is the latest and largest example of an all-metal aeroplane, and is the biggest monoplane flying. It is constructed entirely of duralumin. The fuselage is devoid of longerons, or longitudinal spars, and consists of riveted sheet duralumin, kept rigid by a series of internal duralumin girder bulkheads. Indeed, the internal bracing of the fuselage is somewhat reminiscent of that of the Zeppelin airships. The fuselage is of very deep cross-section. The wings are of the German high-lift type, of very great thickness, and carry the four engines, two on each wing.

The engines are carried in nacelles, which are actually built into the leading edge of the wing, which is of such thickness as to permit the mechanics to crawl through a tunnel in the interior to reach the engines. Each engine nacelle has a seat for a mechanic, and is fitted with a nose honeycomb radiator. The engines are the 260 h.p. Maybach. These motors were the motive-power of the Zeppelin airships, and the sound of them is familiar to many people in this country.

The wings are, like the rest of the machine, covered with duralumin sheet, which is an integral part of the wing structure, adding vastly to its strength and rigidity, and is not, as in the ordinary wood and fabric wing, a mere covering. The wings are fitted with the usual type balanced ailerons.

The under-carriage is of great strength and simplicity. It consists of horizontal V struts on either side carrying the wheel axle, thus avoiding a long axle, and a third telescopic strut, very deep from front to back, which runs from the wheel axle to the wing, midway between the engine nacelles. This strut is fitted with shock absorbers. Each axle carries twin side-by-side wheels of large size, about 4 feet in diameter.

The pilot's seat is on the top of the fuselage and gives a clear all-round view. The fuselage is furnished for the accommodation of eighteen passengers and a crew of four or five, and has a pantry, lavatory, and other luxuries. Although not particularly elegant, this great mass of glittering metal is a magnificent sight in flight, and bears throughout evidence of that excellence of design and construction associated with the Zeppelin works. The machine flies remarkably well, in spite of its heavy wing loading, and is easily dismantled for transport by railway or ship.


ZEPPELIN GIANT MONOPLANE IN FLIGHT.

The main dimensions of this colossus are: Span, 104 feet; length, 59 feet 6 inches; height, 16 feet 8 inches; weight empty, 11,660 lb.; weight loaded, 20,196 lb. Total h.p. 1,040. The speed attained during the early trials was 111 miles an hour. Afterwards this was increased to 130 miles an hour. It will be seen, therefore, that it has a considerable turn of speed, and is probably the fastest large machine in the world. It will permit of being flown, however, at a very much more economical speed. Indeed, the above figures give some food for reflection. For one thing the wing loading (total weight divided by lifting surface in square feet) is extremely high, about 17 lb. to the square foot, or over twice what is considered normal. Secondly the high speed. This probably is partly due to the good habit of German aircraft engines of working at something above their specified h.p., and partly to the careful streamlining of the machine and the sensible distribution and installation of the engines, which obviously offer very little obstruction to the air.

Another point is the remarkably low landing speed claimed by the constructors, which, with the very high wing loading and considerable speed of the machine, is stated to be no more than 55 miles an hour.

Altogether this is a very remarkable machine, probably the most original and most discussed of post-war aircraft, and from which there is much to be learned. Let us hope it is a portent of the future, a forerunner of the giant passenger-carrying aeroplanes that within a few years will be found flying regularly on the far-reaching air lines of the world.

Learning in Man and Animals

By Victoria Hazlitt, M.A.

Assistant Lecturer in Psychology at Bedford College, University of London

When animal learning is mentioned, the mind is apt to conjure up pictures of a dog sitting with a piece of biscuit on his nose, or of an elephant dancing, or of some other unusual and unnatural feat. It is perhaps for this reason that we are inclined to think of the animals' learning process as quite different from our own. In view of this tendency it may prove interesting to institute a comparison between the laws of learning in man and in an animal as low in the scale as a rat.

Some of the laws of human learning have been studied in experiments with meaningless syllables. These "nonsense" syllables are arranged in series and repeated as uniformly as possible until they are known. The learner endeavours to avoid making associations, as they would introduce an incalculable factor into the results. His work thus consists in forming verbal motor-habits which are one of the most characteristic of human activities. One of the rat's most characteristic activities is finding his way about in subterranean labyrinths. In order to study his process of learning under such conditions, a considerable number of experiments have been carried out in which the rat has had to learn his path through a maze. The rat is put at the entrance and is rewarded with food when he reaches the end. On the first occasion he usually spends a long time running into blind alleys and returning on his path. After a few repetitions, however, he avoids blind alleys and completes his journey in a minimum time. By means of these two methods—the one for human beings, and the other for rats—a number of problems connected with learning have been investigated.

It has been found that the number of repetitions for learning a long series is disproportionately great when compared with the number for learning a short series. For example, an experimenter who required, on an average, sixteen repetitions in order to learn a series of twelve syllables required thirty repetitions in order to learn a series of sixteen syllables, i.e. an increase of 33⅓ per cent. in the number of syllables involved an increase of 87½ per cent. in the number of repetitions necessary for learning. The following table shows that the same is true of rats:

Length of Maze.	Number of Repetitions for Learning
9 feet	3·75
22 feet	9·73
27 feet	18·0
33 feet	27·0

These figures show that any increase in the length of the series to be learned by man or rat necessitates an increase approximately twice as great in the number of times that the series must be repeated. In the case of human beings, this is true only of learning which is not helped by the meaning of the material to be learned. Meaning and interest tend to reduce the effect of the length of the series.

Another fact which has been established experimentally is that the number of repetitions necessary for learning a given series by heart is affected by the distribution of the repetitions. For instance, a poem will be learnt with a smaller total number of repetitions if these are given once per day than if several are given at a time, and two repetitions on each of twelve days will ensure nearly five times as much being remembered as eight repetitions on each of three days. Experiments with rats show that the same law applies to their learning. When they run in a maze three times per day, the total number of repetitions which they require for learning it is almost twice as great as the total number required when they run in it only once per day. On the other hand, when the interval between the repetitions is greater than one day, the total number of repetitions increases for both man and rat. Human subjects remembered almost twice as much from eight daily repetitions as they did from eight repetitions given on alternate days. Rats who required six repetitions to learn a maze with daily repetition required twelve to learn it when they ran in it with a two-day interval.

A third group of facts which has been established with regard to learning by heart concerns the most economical division of the material. If a group of people were asked to learn a poem by heart, practically all of them would repeat each verse over and over until it was known before going on to the next. Does the universality of this method rest on its superiority? Experimental evidence shows that it does not. The most economical method is to repeat the poem as a whole, or, if very long, to divide it into the largest sections that can be grasped as wholes. The size of these will vary with the experience and intelligence of the learner. If the material to be learned is very difficult and unfamiliar, it may be better to learn it in short sections. It appears also that sectional learning is better for motor activities such as complicated drill movements. Recent experiments have shown that rats learn a maze more quickly by learning it a part at a time, and that human beings resemble them in this when they learn maze paths under experimental conditions.

Another aspect of human learning is that the acquirement of one habit usually makes it easier to acquire another similar to it. Thus each piece of music is, on the whole, learned more easily than the last. The habits formed in one piece do not interfere with the habits necessary for another. In this, again, the rat resembles man. He learns each successive maze with greater ease, and attacks his later problems with the confidence and apparent enjoyment of his performance which characterise the work of a skilled musician.

Judging from the evidence at hand, there is an extraordinary resemblance between the laws of animal and human learning when the task concerned is the acquisition of motor habits. The inquiry into the subject of the differentiation of human from animal learning on levels higher than that of the acquisition of motor habit offers a fascinating field for research. While a great deal has been written upon the subject, there has been comparatively little exact experimental work.

Great Britain in the Latest Age. From Laisser Faire to State Control. By A. S. TURBERVILLE, M.A., and F. A. HOWE, B.Sc. (John Murray, 7*s.* 6*d.*)

Measure Your Mind. By FRANK P. STOCKBRIDGE and M. R. TRABUE. (Harrap & Co., 10*s.* 6*d.* net.)

A book on Mental Tests by two Americans. See review, p. 106.

The Islanders of the Pacific, or The Children of the Sun. By Lieut.-Col. T. R. ST. JOHNSTON, late District Commissioner of the Lau Islands, Fiji. (T. Fisher Unwin, 25*s.*)

An Up-to-date Meteorological Equipment—II

By Donald W. Horner, F.R.A.S., F.R.Met.Soc.

SELF-RECORDING RAIN-GAUGES

IT is a curious fact that the first rain-gauge to be constructed was not an ordinary instrument but a self-recording one, the principle of which was suggested by Dr. (afterwards Sir Christopher) Wren, who is better known popularly by his architectural work than by his scientific experiments. On January 22, 1662, he demonstrated this particular experiment before the Royal Society by filling a vessel with water, which emptied itself when filled to a certain height. Ten years later a self-recording rain-gauge on this plan was constructed to the order of the Royal Society.[1]

In the first ordinary rain-gauge that was constructed the water was not measured but weighed. This *pluviometer* was invented by Mr. Robert Hooke in 1695.

This rain-gauge was of a very primitive design, merely consisting of a large glass bottle holding more than two gallons and having a neck 20 inches long. The funnel too was made of glass, and was 11·4 inches in diameter, the whole being fixed in a wooden stand, something like an old-fashioned jelly-stand. The funnel was steadied by two pack-threads attached to the frame by pins and passing over the edge of the funnel. The amount of water collected was carefully weighed every Monday morning, and it was found that between August 12, 1695, and the same date in 1696, using troy weight, the rainfall in the interval weighed 131 lb. 7 oz. 113 grs., equivalent to 29·11 inches.

This digression into the history of the rain-gauge has been made to show what a very considerable advance has been brought about since the early days of rainfall recording. Primitive simplicity has given way to the complicated mechanism of the up-to-date instruments about to be described.

In *British Rainfall* for 1905 Dr. H. R. Mill, the Director at that time of the British Rainfall Organisation, said: "Rainfall duration has not yet been much investigated, and it would be of real importance to obtain additional records on which to base an opinion as to the geographical distribution of rainfall duration."

To meet this requirement Messrs. Negretti and

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[1] "Contribution to the History of Rain-gauges," by G. J. Symons, F.R.S., *Quarterly Journal*, R. Met. Soc., vol. xvii, No. 79.

Zambra brought out a recording rain-gauge called the *Hyetograph*, constructed under Halliwell's patent. The [illegible] was approved by Dr Mill and since then

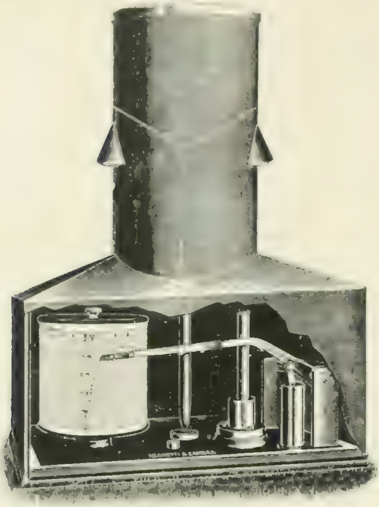

FIG. 5. THE "1908" HYETOGRAPH (*Original Pattern*).

(1908) an improved form has been introduced, known as the "1919 Hyetograph."

In Fig. 5[1] we see the original pattern instrument, and in Fig. 6 a sectional diagram of the 1919 improved apparatus.

It should be mentioned that in Halliwell's Patent Rain-gauge the water in the float cylinder is made to siphon away.

To obtain an absolutely trustworthy automatic siphon would be a great deal too expensive for use in a gauge at a relatively low price, and to obviate this difficulty the Hyetograph was constructed with a mechanical device which affects the pen only, and gives an open scale of ½ inch of rainfall recorded on a chart 3 inches high.

When the Hyetograph is in action, so long as rain is falling the float D (Fig. 7) continues to rise, up to a maximum capacity of 4¼ inches. On a spindle E, rising from the float D, are a number of projecting pins FF which engage successively with a projection on the lever G, this lever being so pivoted that when the pen reaches the top of the chart the lever disengages with the pin and falls by its own weight on to the next lower pin, which is so placed to allow the pin to fall to zero on the chart. The float therefore continually ascends during rainfall, but at each successive half-inch of rain the pen descends to zero and recommences its upward movement.

As no automatic siphon is used, it is obvious that the rain will collect in the float-chamber until it is removed, and the float cylinder is made sufficiently large to allow an accumulation of over 4 inches of rainfall, the maximum usually likely to occur in one day in any locality in Great Britain and Ireland, except the wettest parts of the Lake District and on high mountains.

In order to remove the water the Hyetograph is constructed with a specially designed hand-started siphon which is actuated when desired; this empties the float-chamber of any water which may have accumulated therein.

The chart is wound round a cylinder which makes one revolution in 24 hours; the effective length is 10·8 inches, giving 0·45 inch for an hour.

From this brief description of the instrument it will be noticed that its advantage over other apparatus of its kind is its simplicity; it has very few parts to get out of order and it is very easy to set up. A good plan is to erect it over a 6-inch drain-pipe, the large end of the pipe being uppermost, so that the flange is level with the ground; then when the water is siphoned out of the Hyetograph it flows directly into the pipe and so into the ground.

The general principle of the 1919 Hyetograph is similar to that already described, but has embodied in it some important improvements. In the older instrument the trace on the chart was a curve; in the new one it is a *straight line*, and anyone who has had experience in tabulating traces will at once appreciate the advantage of this arrangement.

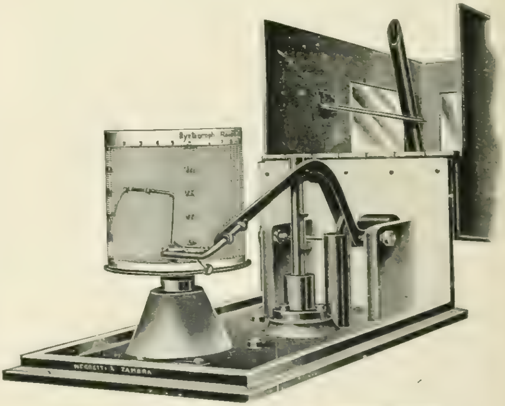

FIG. 6. THE "1919" HYETOGRAPH (*Sectional Diagram*).

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[1] Illustrations reproduced by permission of Messrs. Negretti and Zambra, London.

Also in the new instrument the pen-arm is counterpoised to obviate the effect of friction. Possible friction between pen and chart is also eliminated by the use of the swinging pen-arm. The pen rests lightly by its own weight on the chart. This ensures great clearness of writing.

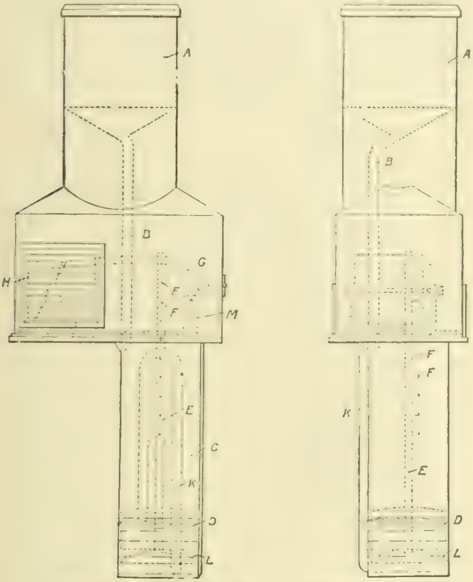

FIG. 7.—SECTIONAL VIEW OF THE HYETOGRAPH.

A more expensive form of Self-Recording Rain-gauge is that known as the "Fernley" (Fig. 8), designed at the request and under the supervision of Mr. Joseph Baxendell, the Director of the Fernley Observatory, Southport. This gauge may be classed with the Hyetograph as a first-class Recording Rain-gauge. In this form of self-recording gauge the rain-water passes from the funnel into the float-chamber and causes the float to rise as far as the top of the chart, this representing $\frac{1}{2}$ inch of rainfall. At this point the water siphons away, the float falling to zero in six seconds, ready to commence a fresh trace. The siphon is actuated by means of a tilting bucket. As soon as the float and pen reach their highest point, the bucket overturns and the water pours through a pipe. In this way the reservoir is quickly emptied.

Having now outlined the principles and mechanism of the two most important forms of self-recording pluviometers, we will proceed to show how they can be utilised in the pursuit of our knowledge of the cause and effect of precipitation.

On May 15, 1907, Dr. Hugh Robert Mill, then President of the Royal Meteorological Society, read a paper on "The Best Form of Rain-gauge."[1] In this paper he stated that the three best forms of ordinary rain-gauge are the "Snowdon," the "Bradford," and the "Meteorological Office" patterns, and later (in 1908) he gave his unqualified approval of the "Hyetograph." It will be seen from this that we have now treated of all the most important forms of pluviometer, and it only remains to show the relation existing between observations made with ordinary rain-gauges and self-recording instruments.

When we measure the rainfall at 9 a.m. in a simple rain-gauge and write down the result against the *previous day*, as is the usual custom, we know only that a certain amount of rain-water has been caught in the gauge during the past twenty-four hours, but we have no means of discovering the intensity of the fall at any particular time during the period.

The self-recording gauge can give us this information. During the whole of the twenty-four hours a continual record is being taken on a revolving clockwork drum, and when we visit the instrument and look at the chart it tells us at once the rate at which rain was falling at any particular time.

With a gauge such as the Hyetograph it is possible to secure the maximum rate of rainfall during thunderstorms and other heavy downfalls, in a way which would be entirely impossible with an ordinary gauge, and we can also obtain the mean hourly fall for the month or year.

For some years past in *British Rainfall* a section has been devoted to heavy falls in short periods, and the discussion of these values would have been impossible without the results obtained by the improved form of self-recording rain-gauge.

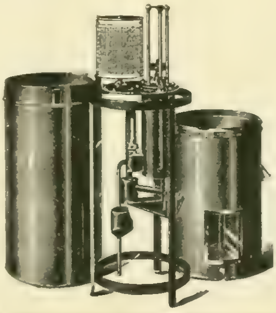

FIG. 8. FERNLEY SELF-RECORDING RAIN-GAUGE.

In the previous article it was mentioned that a "rain day" consisted of one on which 0·01 inch or more of rain had fallen. It is pointed out, however, in *British Rainfall* for 1919, just published, that this value is gradually becoming obsolete, and for the following reasons: The recognised "rain day" for observers measuring in millimetres is a day on which 0·2 mm. or more is recorded. If the inch be the unit employed, a fall of 0·01 inch or more constitutes a "rain day." In a 5-inch rain-gauge these amounts are represented by 3·2 c.c. and 2·5 c.c. of water respectively, and this discrepancy in these units of measurement is added to the already existing sources of uncertainty given in the previous article.

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[1] *Quarterly Journal* of the R. Met. Soc., vol. xxxiii, No. 144, p. 265.

The obvious remedy for this state of affairs is to increase the value to a larger quantity, provided, of course, that the amount is not *unduly* large. The smallest value on the respective rainfall scales at which the inch and millimetre virtually coincide is, as we have previously stated, 1 millimetre, which equals 0·04 inch almost exactly. Now, 1 mm. of rain in a 5-inch gauge means 12·7 c.c. of water, and 0·04 inch means 12·9 c.c. This amount is sufficiently large to eliminate the small errors occasioned by the difficulty of accurate measurement, and small enough to include all days of significant rainfall.

It is not, however, at present proposed to do away with the present definition of a rain day, but to supplement it by another term, a "wet day," which shall be considered as a day ending at 9 a.m. on which 1 mm., or 0·04 inch, or more of rain is recorded.

Moreover, it has been decided that a "dry spell" shall be a period of fifteen, or more, consecutive days no one of which is a "wet day" according to the foregoing definition; and a "wet spell" shall be a like period each one of which is a "wet day."

Till recently it has been the practice to take a period of more than fourteen consecutive days every one of which is a "rain day," that is, a day on which 0·01 inch or more fell, and to call it a "rain spell"; and to take a similar duration of time without measurable rainfall and term it an "absolute drought." It has been found, however, from figures published in *British Rainfall* during seventeen years, that the "rain spells" greatly outnumber the "absolute droughts." It is hoped that the new definitions will tend to eliminate this undesirable disparity.

Improvements are still being made in these instruments. Messrs. Negretti and Zambra will shortly introduce a Recording Rain-gauge with a natural siphon action, and also an instrument for recording the actual rate of fall of rain at any given moment. The Meteorological Office has one of each of these instruments under test at the present time, and the results of its investigations will be awaited with interest by meteorologists.

In conclusion, it must be remarked, before leaving the subject of rain-gauges, that whatever kind we employ they must be set up *perfectly level*. Especially is this the case with self-recording instruments, whose level it is necessary from time to time to test with a spirit-level. If, however, the instrument is set up originally in a cement-concrete bed, and levelled up accurately, further trouble in this respect is unlikely.

The Elder Edda[1]

THE Great Cold that they had dreaded has fallen upon the Scandinavian gods: the winter that knows no spring. The Grey Wolf has devoured Woden and stands on the high places of Asgerd, a deadlier than the breed of Fenri that the Sibyl prophesied, the Grey Wolf of forgetfulness. For there has been a twofold Doom of the Gods. There was the coming of that Other whom the Sibyl dared not name, and for the sacred ash Igdrasil the uplifting of the Holy Rood. And again, long after, when the wheel had come full circle and the pagan years returned, it was to find

> "Many a fallen old Divinity
> Wandering in vain about bewildered shores."

It was not the Giants that held their inheritance, but the Olympians. Olympus had conquered Asgerd, for "first in beauty should be first in might," and few have eyes for Freya riding on her Boar, however golden his bristles, when they have

> "Hailed thee re-risen, O Thalassian,
> Foam-white from the foam."

Thor and Woden, Loki and Frigg, one looks for them in vain among the "damnèd crew" in Milton's *Ode on the Morning of Christ's Nativity*. Moloch and moonèd Ashtaroth are there, but these have escaped the bale of hell, because their very memory was forgotten.

It was, curiously, in the eighteenth century, the century of the spiritual east wind, that the frost began to yield, and Gray, with his shy scholar's passion for wild earth, discovered again its gods. For gods of wild earth they are. The Greek gods have captured the world of the imagination, and the "diverse far-off image of delight" clothes itself in their radiant names; but they are fair-weather gods at best. Always behind Apollo and Aphrodite one sees sun-stained marble and a sickle-sweep of warm sand and the blue Greek sea. But in the northern islands it is Thor who shouts across to the ferryman when the river comes down in spate, and Loki's face that leers from the green gnarled bark of the trees in the woods; Weyland's smithy stands by the brawling ford, and Woden, the maker of secret spells, is the hooded figure abroad in the darkening fields. These are the gods of the Elder Edda, not yet ascended into Valhalla, not yet detached from the stone and the tree-trunk that was their earliest shrine.

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[1] *The Elder Edda and Ancient Scandinavian Drama.* By Bertha S. Philpotts, O.B.E., Litt.D. (Cambridge University Press: 21*s.* net.) [The *Elder Edda* is the very oldest collection of Scandinavian Myths.]

This is why Miss Philpott's study of the Elder Edda is for all men, and not for scholars only. " My aim," she writes, " is simply to place before scholars a theory of the dramatic origin of the Elder Eddic poems." But in unravelling the ritual of which drama was born, the old world has staged itself, and the flame again wakens about the barrows of the dead. Even the beast disguises that so revolted St. Egbert and St. Theodore, for which one did three years' penance, are seen no longer bestial, but guises of the friendly creatures who wept for Balder, and once shared our life as they do to this day, until one grows tall enough to stoop to pat a dog. The only drawback is that so fine a gift of translation has been used so sparingly. Miss Philpotts had intended, she writes, to give a translation of the more important poems in an appendix, and did not, lest she should forestall another and a better hand. But there is no *mare clausum* in translation. Some of us, knowing the druid world that masks itself behind the formal scholar's title of the *Corpus Poeticum Boreale*, would have held that felicity of translation could no farther go. " Now I swear that there shall never be a greater marvel than this, early or late at Sevafell. . . . It is time for me to ride the reddening roads, to let my fallow steed tread the paths of air. I must be west of Windhelm's bridge before Salgofni awakens the mighty host." Yet hear this— " Now I swear that men at Sevafell shall marvel at naught hereafter, neither soon nor late. . . . But it is time for me to ride the reddening ways, to urge my pale steed on the paths of the air. I must be west of the bridge of Windhelm before the cock on Valhöll awakes the warrior host."

As to the development of the actual thesis, it marches like the sea. One's pleasure in reading it—it had better be read at a sitting—is the satisfaction of a demonstration in mathematics. Every chapter is " the stroke of a strong swimmer." One is the more malcontent that the last two chapters have somewhat suffered from the toll that the last five years have taken from scholarship. The analogy between Greek drama and this other, arrested at the moment when tragedy was about to break the ritual mould, might have made another book. For the last, on the bearing of the theory on the ballad, the epic, the folk and the Church play, it is a chapter of valuable suggestion; but when it ceases to be suggestive and becomes dogmatic, consent is less secure. " The religious origin of the heathen drama will hardly be questioned. But the heathen origin of the ecclesiastical drama practically follows from that premise." Now, it is to be remembered that ecclesiastical drama rose first, not in places where the heathen tradition was strongest, but in the great Benedictine strongholds such as Fleury and St. Martial of Limoges and St. Gall, side by side with the enriching of liturgical music, the art of stained glass and of engraving in gold, all of them tributaries of the great liturgical development that centred in Cluny, the magnifying of the *opus Dei* which was the ideal task of the Benedictine Order. " Religious drama in England was known in the Anglo-Saxon period," but it was founded on the customs of Fleury and Ghent, and it is the vexation of scholarship that it seems to have taken so little root till after the Conquest. Moreover, the liturgical play was not " discouraged by the ecclesiastical authorities," except by some of the austerer sort, the eternal Puritan voicing himself in Gerhoh, or our own Grossetête of Lincoln; and the famous decretal of Innocent III against *ludi theatrales* was almost certainly directed not against the " representationes " of the mystery of the faith, but the abuses of the Feast of Fools. Nevertheless, the very over-emphasis with which the theory is stated may help the balance to right itself. It has been the tendency of recent scholarship to stress too much the provenance of the dramatic seed, and ignore the " shaping spirit of imagination " inherent in the soil where that seed was flung. The Elder Edda has proved the richness of it, not only in promise but in achievement. When the author of the *Lay of Helgi Hundingsbane* saw Sigrun face to face with her lover, and between them the bodies of the father and brother that he slew——

Helgi said: " Take comfort, Sigrun! A Hild hast thou been to me.
Kings cannot withstand Fate."
Sigrun said: " Fain would I that some should live who now are dead,
And yet would I clasp thee in my arms "—

he saw tragedy, the thing itself, as the Greeks saw it. It is small wonder that Miss Philpotts speaks a little wistfully of " that tragic drama which suffered no untimely death, but was allowed to develop to its full stature." The tragedy of the Elder Edda is broken, but it is the broken figure of a god.

Helen Waddell.

The " Oresteia " of Æschylus. Agamemnon, Chœphori, Eumenides. The Greek Text with an English Verse Translation by R. C. Trevelyan. (Bowes & Bowes, 5*s*.)

Tropical Agriculture[1]

By C. A. Barber, Sc.D., C.I.E., F.L.S.

This book, we note from the preface by Mr. J. MacKenna, is based on a series of lectures delivered by the author to his class of students in the Cawnpore Agricultural College while he was Principal. As it deals with the whole fabric of agricultural economics in the United Provinces, its appearance at the present time would appear to be singularly opportune, for the daily papers are filled with accounts of widespread disaffection among the peasantry of this part of India, where the agitator has been specially busy of late. The lectures are apparently intended for the land-owning classes, who have recently suffered considerable losses from rioting and wholesale looting; they were not apparently intended for the education of the cultivator himself, and this should be borne in mind in reading the book, as it assumes a considerable education and knowledge of local conditions. The book will thus present difficulties for those not in some way prepared for the vast differences between agriculture in a temperate climate and that in the warmer parts of the globe, and for the special conditions prevailing in the North of India. We should, therefore, warn the student of tropical agriculture that, for full advantage to be obtained from its perusal, much preparatory work will be necessary. It is a book rather for the advanced English student than for those who are only commencing this complicated study.

The author commences with a section on the origin of the primitive community, tracing it in the first instance to the increase in population and a corresponding difficulty in obtaining food; from this, by easy stages, we are led to the formation of the village, and, later on, to the great city, drawing its supplies from distant parts of the country with the development of railways, and even from different countries as shipping increases. It is a fortunate circumstance that, in this study of evolution, examples can readily be drawn from India itself, where we have all stages from the wandering savage to the civilised inhabitant of the large town. After thus laying his foundation, the author develops his study in two directions concurrently, namely, those of agriculture and economics; and in each of these a separate section is devoted to the basis on which the science is founded and on its development.

Such a work is exceedingly welcome at the present day. The student of tropical agriculture is at present very badly off for books, and much of his time and that of his teachers is inevitably dissipated in hunting up papers in the agricultural journals of different countries—a laborious and thankless task. It is true that a number of treatises of great value have appeared from time to time on single crops, such as cotton, sugar, rubber, tea, coffee, cacao, and there are also several books on what may be called "planters' products"; but we are singularly deficient in works of a general character. The book on tropical agriculture has still to be written. And the reason for this is not far to seek. Works of this nature, the description of the vegetable products of a country and the methods of cultivation and their extraction, need the personal touch. This will not be present in anyone who has not himself taken part in the work, and the domain is so vast and varied that few sojourners in the tropics can have studied adequately more than one or two different regions. The compilation of a satisfactory agricultural textbook of our own small country would cover a number of volumes: what can we do with a hundred countries, scattered over the tropical belt, differing in almost every conceivable respect—physical configuration and climate, races varying from complete savagery to ancient civilisation, widely diverse crops and still more widely differing methods of cultivation? Any attempt to bridge this gap in our library is to be encouraged, and Mr. Martin Leake's book, which deals with fundamentals rather than details, and with a wider aspect of agricultural economics, should be read by every thoughtful student of the subject.

To give some idea of the variations met with in tropical agriculture, judged by methods of cultivation alone, it is first of all necessary to formulate some method of classification. Among many possible ones, we have divided the subject into three rough groups, radically differing from one another—namely, the collection of the produce of wild plants; the settled, ancient cultivation of civilised communities, self-contained and devoted to their own requirements; and the cultivation introduced by European settlers intent only on the export of their produce to the centres of population in the temperate regions from which they have migrated. These three differ very widely in every respect, although they insensibly pass into one another in most countries.

The mere collection of the produce of wild plants is characteristic of a primitive stage of development, and yet we still receive some of our most valued raw materials in this manner. Such, for instance, are the oil from palms on the west coast of Africa; rubber, until recently obtained from the forests of the Amazon and the forest regions of Africa; gums and spices from the entire fringe surrounding the great deserts of North Africa. Sugar and spirit are obtained from the most varied palms; starchy foods from palms, cycads, roots;

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[1] *The Bases of Agricultural Practice and Economics in the United Provinces, India.* By H. Martin Leake, M.A., Sc.D., F.L.S. (Heffer and Sons, Ltd., 1921, 15s.)

cola from the West African forests ; shea butter from the hinterland of Nigeria and the Gold Coast, and so forth. And to these may be added many other plants only recently brought together in orderly plantations : pepper, cacao, cocaine, coffee, quinine. There is, in fact, a constant striving, even in these latter days of progress, to emulate the work of the primitive savage, who brought a few seeds and planted them near his chosen place of abode.

The range of ancient agriculture in the tropics, which is the heart of the study, may best be learnt by constructing a map of the world, showing the employments of mankind in the fifteenth century, the age when we began to appreciate how big the world was. The turning-point coincides with the finding of the Cape route to the Indies and our discovery that a great western continent existed. In the New World thus discovered, little of settled agriculture existed beyond the domain, on the western coasts, of the Aztecs and Incas, whose cultivation is unfortunately lost, but to whom we are indebted for the best varieties of cotton, tobacco, pineapples, maize, and other crops. The rest of the Americas, largely covered by dense forests, was ranged by warlike peoples who devoted themselves to hunting and fishing. In Africa, the great central plateau was covered from north to south by wandering tribes, often at war with each other, and little settled agriculture can be traced but in a few isolated tracts, always excepting the extreme north, cut off by impassable deserts, the Mediterranean coast from Egypt to Morocco. In Oceania, with its exuberant vegetation, little more was needed by the inhabitants than to put out their hands and gather the fruits of the earth. But in Asia, with its teeming populations, a very different state of things existed. We know that, from remote times, thousands of years before the Christian era, agriculture was a valued art, and, to emphasise this, the five sacred crops, rice, wheat, barley, millet, and beans, were annually planted with much ceremony by the Emperor and his courtiers. In India, cotton and sugar-cane were cultivated also in remote antiquity, although the earliest existing references are only 800 years B.C. And doubtless similar circumstances prevailed throughout the south-eastern portion of the continent and the adjacent larger islands. The study of the vast accumulated agricultural lore in these tracts is a life's work, and forms the basis of tropical agriculture of to-day.

On an entirely different plane is our third division, the agriculture responsible for our coffee, tea, cacao, rubber, and to a less extent sugar, cotton, and spices, broadly included under the title of "planters' products." Most of these owe their increase to the invasion of tropical countries by inhabitants of temperate regions, bringing with them their energy and capital, and capable of effects quite impossible to the local races. Although cotton, sugar-cane, cacao, and rubber are produced at low elevations, the settlers naturally congregated together, chiefly in the more elevated tracts, where the population was scanty and the climate cool and suited to their needs. And this scantiness of population made it necessary to introduce labour from the excess in the plains. Cultivation in these regions is of an entirely different nature from that in the plains, and its principles have been largely built up on the unfortunate experience of pioneers : the planters are now laboriously remedying the errors of the past, and fighting the hordes of pests and diseases introduced by inefficient agricultural methods. Almost all of the plants in this tract are perennials, often shrubs or even trees, which fact, together with the irregular contour of the land, rules out the plough, and cultivation, therefore, depends on hand labour. The planters have, accordingly, introduced the spade and fork, unknown in the plains.

Naturally, no general rules can be laid down for the treatment of soil in such different conditions, and the conditions in the separate staples in each class differ quite as widely among themselves. The methods of cultivation of rice, which is a water plant, and the millets, which will thrive on the minimum of rainfall, differ as the poles ; so do the intensive field work in the cane-fields and the extensive among the various fibre plants. The only way is to take the crops and countries one by one, recognising the fact that the study of tropical agriculture is limitless. A whole life may be spent in the study of cotton or sugar or rubber with gaps still left in one's knowledge. But the study, if disheartening, is full of interest, and well worthy of a place in the curricula of our schools, where it is gradually forcing its way to recognition.

An Introduction to String Figures. An Amusement for Everybody. By W. W. ROUSE BALL. (Heffer, 2s.)

Mr. Rouse Ball's book will be a joy to all who are interested in making figures out of a piece of string with the hands. He has collected all the best figures, describes very clearly how they are made, and gives diagrams to show the completed work. This is an amusement for everybody and, like games of patience or jig-saw puzzles, will be especially suitable for whiling away many a dull hour for an invalid in bed. Everyone who possesses a piece of string and is interested in doing stunts with string should get this book and learn to make the figures.

The Backward Peoples and our Relations with Them. By SIR HARRY JOHNSTON. (Oxford University Press, 2s. 6d.)

Reviews of Books

The Measurement of Intelligence. By PROF. LEWIS M. TERMAN. (Harrap & Co., 8*s.* 6*d.*)

The Intelligence of School Children. By PROF. LEWIS M. TERMAN. (Harrap & Co., 8*s.* 6*d.*)

Measure Your Mind. By F. P. STOCKBRIDGE and DR. M. R. TRABUE. (Harrap & Co., 10*s.* 6*d.*)

These three books are not only what our elders and betters call highly instructive, but they are also exceedingly good fun. If they are read and studied in the order I have placed them, they should serve, I think, to introduce readers to a very fascinating subject—that of mental tests. The titles sound dry enough. Intelligence, school-children, measuring the mind, these call to our minds the pedagogue. But remember we are not in school. And these books, as pedagogues out of school may be, are interesting, entertaining, and at times highly amusing.

It was a gentleman of the name of Binet, a Frenchman, who was the first to put this business of mental testing on a scientific basis. He succeeded, as Professor Terman has said of him, in bringing down a good deal of psychology from the clouds and making it useful to men. But fifty years ago Francis Dalton had predicted that sometime it might be possible to obtain a general knowledge of the intellectual capacity of a man by sinking shafts, so to speak, at certain points. This is what mental tests do. Galton's prediction is now in process of being realised.

Binet spent fifteen years in working out his system of mental tests. It was published in 1908, and is known as the Binet-Simon Intelligence Scale. This scale consisted of fifty-four tests ranging in difficulty from tests that may be passed by the average child of three years to tests which would be considered difficult enough by the average grown-up. This work of Binet's was great pioneer work. His scale has since been considerably modified by Professor Terman and his pupils at Leland Stanford Junior University in California. They have increased the number of tests to ninety, and have extended the scale sufficiently to measure the intelligence of "superior adults." These tests are called the Stanford Revision. They give, I think, a better diagnosis of our mental capacity than the original Binet-Simon scale. They include tests of memory, comprehension of language, size of vocabulary, orientation in time and space, co-ordination between hand and eye, knowledge about familiar things, judgment, ability to find likenesses and differences between common objects, arithmetical reasoning, resourcefulness and ingenuity in difficult practical situations, ability to detect absurdities, apperception, the speed and richness of association of ideas, the capacity to generalise from particulars, the ability to deduce a rule from connected facts and so forth.

Here is one of the Stanford problems:

A mother sent her boy to the river and told him to bring back exactly seven pints of water. She gave him a three-pint vessel and a five-pint vessel. Show me how the boy can measure out exactly seven pints of water, using nothing but these two vessels and not guessing at the amount. You should begin by filling the five-pint vessel first. Remember, you have a three-pint vessel and a five-pint vessel, and you must bring back exactly seven pints.

This problem is given orally, but may be repeated if necessary. The person questioned is not allowed pencil and paper. The time allowed is five minutes.

Below is another problem:

Repeat Backwards 4-1-6-2-5-9-3; 3-8-2-6-4-7-3; and 9-4-5-2-8-3-7.

A test which should be passed by the "average adult" consists in repeating twenty-eight syllables. The sentences for this test are:

(*a*) *Walter likes very much to go on visits to his grandmother, because she always tells him many funny stories.*

(*b*) *Yesterday I saw a pretty little dog in the street. It had curly brown hair, short legs, and a long tail.*

The sentence must be repeated without a single change of any sort. The test is passed if one sentence is repeated correctly.

These, however, are merely samples, and away from the context and the rules and regulations governing them they lose much of their importance. The whole thing (the Stanford Revision) is explained lucidly and at length in *The Measurement of Intelligence.* The necessary technical terms are carefully explained, the reliability of the methods employed is discussed, and the instructions for giving the tests to children are set forth in detail.

A reader looking through the tests might wonder if psychologists or teachers are justified in attributing the significance they do to tests many of which are familiar as parlour games or as puzzles in the children's page of the popular weekly. Here, as in every scientific investigation, we must be guided by what the experts say. Their opinion is that the significance of mental tests lies in the fact that each test and the scale as a whole have been carefully standardised on the basis of age. The series of tests has been tried upon many hundreds of normal children. A boy who can pass a test which experience has shown can be passed by the *average* child of eight years is said to have a "mental age" of eight. If he can pass not only the eight-year-old test but also those set for children of nine and ten years, he is said to have a mental age of ten years. If he passes the six-year-old test but fails at the seven-year test, however, he has a mental age of six.

The importance of mental age for the teacher lies, then, in the fact that it may be used as a basis for grading the pupils. Should a boy of eleven with a mental age of fourteen leave the class he is in and be put in the higher class in which the average age is fourteen ? Professor Terman says yes, emphatically. He declares that skipping classes in these circumstances is justified, and quotes his experience and authorities for his statements.

In addition to an index of absolute mental level, the mental age, an index of relative ability is necessary in this study. This is called the "intelligence quotient" (IQ). It is obtained by multiplying by 100 the ratio of mental age to chronological age. For example, a clever boy of seven with a mental age of ten would have an IQ of 143 ; an average boy of ten one of 100 ; and a feeble-minded boy of sixteen with a mental age of ten one of 62. In each of these three cases the mental age is the same, but the intelligence quotient indicates whether a child is clever, average, or dull. It is a measure of ability.

Professor Terman's second book (published in February of this year), *The Intelligence of School Children*, deals with the use of mental tests in school-grading, and the proper education of exceptional children. It illustrates the large individual differences in original endowment which exist among school-children, and shows the practical bearing of these differences upon the everyday problems of class-room management and of school administration. He discusses fully what may be expected from, and what ought to be done for, pupils of different degrees of intellectual capacity.

The most interesting part of the book to the general reader is the able study of forty-one "superior" children. Very clever children are commonly supposed to turn out very dull in after-life, and many men and women who show marked ability are commonly supposed to have been "very ordinary" at school. Professor Terman's experience—and it is a wide one—is that both of these common suppositions are wrong. An intelligent boy becomes an intelligent man, a very intelligent boy a very intelligent man, and so on. Feeble-minded or dull children never blossom out into keen, alert, and intelligent men and women. This rule seems to hold generally, and the exceptional cases which have led to the common suppositions mentioned may be easily and reasonably explained.

Professor Terman's top-notcher is a boy D. B. When he was tested he was just under 7 years 5 months. His mental age came out as 13 years 7 months. His IQ consequently was 184 (100 is the normal). This is the highest intelligence quotient in Professor Terman's experience.

D. B. is an American boy. His father is Russian-Jewish, his mother Polish-Jewish. On both sides he is descended from men and women of unusual ability. At six months he stood alone, and at nine months he walked. He played at anagrams when a baby, and learned to read as gradually and naturally as he learned to talk. At three, without his parents knowing he could do it, he picked up a new book suitable for children of nine years and read it through intelligently. He handles "Meccano" models requiring deft fingers, type-writes rapidly, using two fingers only on each hand, and has taught himself printing. He reads for eight or ten hours a week, and always rapidly. He has already read the *Iliad* and much of Shakespeare, and has a particular liking for the historical plays. *Pericles* is his favourite. He has read every history book in his home, and these include Gibbon and Grote. He criticised Gibbon as "having left too much out" in writing about Rome. Among his papers are sundry notes marked "Important things the Scottish kings did," "List of Roman emperors and what they ruled over," etc. History is his favourite subject.

At seven years of age he commenced issuing a weekly playground newspaper, a one-sheet, three-column affair, typed. He writes the whole of it himself, and does the typing too. There is a joke section, an advertising section, a news section, and various extras and incidentals from time to time. The jokes are often such as would not be understood by children below the mental level of twelve years.

This prodigy has other qualities. He is conscientious and truthful. He obeys instructions regarding errands. He is considered above the average in unselfishness. He loves to share his things with others, and remarks at selfishness in others.

Whether he will fulfil this present promise, only the future can decide. But there is every indication that he will become a very great man.

Measure Your Mind, the third book on the list, differs from the two others in that it deals with mental tests, for adults only. There are thirty different sets of tests, each of which has from six to twenty-four questions. Full instructions regarding the conditions under which the tests are to be given and the manner in which marks are to be scored are given with each.

From the marks of each test the person tested is graded as possessing Very Inferior Ability, Inferior Ability, Average Ability, Superior Ability, or Very Superior Ability.

The tests differ very widely, but all are designed as far as possible to test general intelligence, and not merely acquired knowledge or special ability in one or two particular directions. The first deals with the detection of Pictorial Absurdities, and brings back to mind the evenings when we used to do competitions in the boys' magazines—a drawing of an aeroplane with the pilot facing the wrong way, a boy with six fingers on one hand playing with a bat, and so on. Next we have a competition in threading our way through mazes. If we get through them all in a given time we are of "very superior ability." If we do ten only out of twenty, we are of "low average ability." Several geometrical and drawing problems follow, all very interesting, all very amusing. There are addition tests, tests of memory for numbers and of memory for sentences. Next come tests which deal with range of information, spelling tests, and handwriting tests. Disarranged sentences have to be arranged properly and letters to be composed. There is finally a test in what is called poetic discrimination. It is essentially a test for editors. In this test several verses from good poems have been rewritten more or less badly twice, and the problem is to rearrange each set in descending order of merit.

Which is the poorest poetry, and which the best, of these ?—

> Music, when faint voices cease,
>   Continues in the memory;
> Odours, when the violets fade,
>   Linger where their smell was made.
>
> Music lives in the memory,
>   Though the songster's voice is done.
> Sweet odours haunt the nose,
>   Though the violets that waked them are gone.
>
> Music, when soft voices die,
>   Vibrates in the memory—
> Odours, when sweet violets sicken,
>   Live within the sense they quicken.

Altogether an interesting book; very American, with a great deal of sound sense and helpful advice in its pages.

P. K. F.

New Studies of a Great Inheritance. Being lectures on the Modern Worth of some Ancient Writers. By R. S. CONWAY, Litt.D., F.B.A. (John Murray, 7s. 6d.)

The lectures deal with the inner experience of Cicero, Horace as poet laureate, the youth of Vergil, the fall of Cornelius Gallus (published originally in the first number of DISCOVERY), the place of Dido in the history of Europe, and other subjects. The treatment is simple, interesting, scholarly. The lectures are designed to represent some of the elements in the work of the ancient writers, especially those of Rome, which make their study of permanent value; and, in particular, to indicate as clearly as possible how much in the ethical framework of modern society may be traced directly to their teaching.

Books Received

The Elements of Descriptive Astronomy. By E. O. TANCOCK, B.A. (Clarendon Press, 3s. net.)

Laboratory Projects in Physics. By FREDERICK F. GOOD, A.M. A Manual of Practical Experiments for Beginners. (Macmillan & Co., 9s.)

Mechanism, Life, and Personality. An Examination of the Mechanistic Theory of Life and Mind. By J. S. HALDANE, M.D., LL.D., F.R.S. 2nd Edition. (John Murray, 6s.)

Botany with Agricultural Applications. 2nd Edition. By JOHN N. MARTIN, Ph.D. (New York: John Wiley & Sons; London: Chapman & Hall, 21s. net.)

Orographical, Regional, Economic Atlas. Part III, Asia. Editor, THOMAS FRANKLIN. (W. & A. K. Johnston, 1s. 6d. net.)

The Encyclopædia and Dictionary of Education. Part I. Edited by PROF. FOSTER WATSON, D.Litt. (Sir Isaac Pitman, 2s.)

The Somatic Organisation of the Phæophyceæ. Botanical Memoirs, No. 10. By A. H. CHURCH. (Oxford University Press, 5s.)

The Theory of Relativity. By PROF. R. D. CARMICHAEL. (New York: John Wiley & Sons; London: Chapman & Hall, 6s. net.)

Why Do We Die? By T. BODLEY SCOTT, M.R.C.S. (T. Fisher Unwin, 5s. net.)

Principles and Methods of Industrial Education. For use in Teacher Training Classes. By WILLIAM H. DOOLEY, with an Introduction by CHAS. A. PROSSER. (Harrap & Co., 6s. net.)

Principles of Human Geography. By ELLSWORTH HUNTINGTON and SUMNER W. CUSHING. (New York: John Wiley & Sons; London: Chapman & Hall, 21s.)

Insect Life. By C. A. EALAND, M.A. (A. & C. Black, 30s. net.)

Germination in its Electrical Aspect. By A. E. BAINES. (Routledge, 12s. 6d. net.)

Wireless Telegraphy. The Directly-Useful Technical Series. By BERNARD LEGGETT, A.M.I.E.E. (Chapman & Hall, 30s. net.)

Nile and Jordan. An Archæological History of the Interrelations between Egypt and Palestine from the Earliest Times to the Fall of Jerusalem in A.D. 50. By G. A. F. KNIGHT, M.A., F.R.S.E. (James Clarke & Co., 36s. net.)

The Lands of Silence. A History of Arctic and Antarctic Exploration. By SIR CLEMENTS R. MARKHAM, K.C.B., F.R.S. (Cambridge University Press, 45s. net.)

The Practical Electrician's Pocket-Book. (S. Rentell & Co., 3s. net.)

Belgium. From the Roman Invasion to the Present Day. By EMILE CAMMAERTS. The Story of the Nations Series. (T. Fisher Unwin, 12s. 6d.)

Studies in Trench Forestry. By THEODORE S. WOOLSEY junior, with two Chapters by WILLIAM B. GREELEY. (New York: John Wiley & Sons; London: Chapman & Hall, 36s.)

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Editorial Notes

It is a great thing when a man, who knows his subject and wants others to share his knowledge, can so express himself that we, the general public, may not only follow him intelligently, but become interested in his subject, fascinated perhaps. The expert is sometimes prevented from writing on his subject so that his readers get the maximum pleasure possible in reading him, not because he is incapable of writing informingly and interestingly, but because unfortunately he is afraid of a bogey-man. The bogey-man sits up at the back behind the ninety-and-nine who want the matter explained simply, and spoils everything. The lecturer or the writer cannot let himself go. He dare not be funny. He must not express his personality. For there before him is the bogey-man detecting every error, charging him ironically with bringing down matters to his level, muttering "superficial" or "writing down" or "childish analogies," and so it is that sometimes writers who were once good men become stiff and starchy, difficult and dry-as-dust.

* * * * *

Professor Weekley, of Nottingham, is not one of these. He is one of those who believes that, inasmuch as books are written to be read, a good book should be, above all, interesting. His books on *Surnames* and *The Romance of Words* have done much to popularise the highly interesting subject of the origin and meaning of words, but this new book of his, the dictionary,[1] is his best book. It is a triumph. He has given us a jolly book without being superficial or inaccurate. He offers it to those lovers of our language who, "without wishing to stumble about in the dim regions which produce prehistoric roots and conjectural primitive-Teutonic word-forms, have an educated interest in words and an intelligent curiosity as to their origins and earlier senses."

* * * * *

This dictionary does not, of course, fulfil the function of an ordinary dictionary. It does not give pronunciation of the words, and the only definitions given are brief indications necessary to suggest the region of ideas to which an unfamiliar word belongs; there is all the more room, therefore, for an exposition of how, why, and when words and phrases came into our language. The vocabulary is that of *The Concise Oxford Dictionary* or Cassell's *New English Dictionary*, but a great number of scientific and technical words which, for Professor Weekley's purpose, can hardly be regarded as forming part of the English language, have been omitted. Slang words and expressions, hitherto passed over by etymologists, are here historically explained, and foreign words are included if they are likely to occur in reading and in "educated conversation." He has attempted, indeed, to include the whole of the literary and colloquial vocabulary so far as the former is not purely archaic, and the latter not purely technical or local. Quotations form an important feature of the dictionary. Professor Weekley feels that a dictionary "without quotations is too unrelieved in its austerity. Those included here range chronologically from the Venerable Bede to Mr. Horatio Bottomley. . . . Some are given to prove the occurrence of a word, others to illustrate an interesting phase of meaning or an obsolete pronunciation, . . .

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[1] *An Etymological Dictionary of Modern English.* By Ernest Weekley, M.A. (John Murray. 42*s.* net.)

and a few no doubt, because their quaintness, appealed to the compiler."

* * * * *

A review of this book by one who is not a professional philologist, may decently be confined to a few quotations therefrom. Portmanteau words form an interesting class. Many of these are much older than the name itself, which was invented by Lewis Carroll, in 1871, to explain *slithy*, *mimsy*, and other words occurring in *Through the Looking-glass*. ("You see, it's like a portmanteau—there are two meanings packed up into one word.") *Peterloo* (St. Peter's Fields × Waterloo), for example, was invented in 1817. A good portmanteau word should indicate both its meanings clearly, and should not offend a purist too much. *Hunshevik* is not a good example, nor is *petrollick*. *Bakerloo* and *Eurasian* are better.

* * * * *

Proper names that have given rise to words like *bunkum*, *bowdlerise*, *boycott*, and *Mrs. Grundy*, form a second interesting class. Mrs. Grundy was a character in Morton's play, *Speed the Plough*, produced in 1798. Several times in it there is spoken the now familiar phrase: "What will Mrs. Grundy say?" The definitions of *bowdlerise* and of *boycott* are well known. Bunkum comes from a county called Buncombe in North Carolina, the member for which once insisted, towards the end of a wearisome debate in Congress, on "making a speech for Buncombe," i.e. showing his constituents that he was doing something for them. Judge Halliburton's opinion may be quoted in substantiation:

> "All over America, every place likes to hear of its member of Congress and see their speeches; and if they don't, they send a piece to the paper, inquirin' if their member's died a natural death, or was skivered with a bowie knife, for they hante seen his speeches lately, and his friends are anxious to know his fate. Our free and enlightened citizens don't approbate silent members. . . . So every feller, in bounden duty, talks, and talks big too, and the smaller the state, the louder, bigger and fiercer its members talk. Well, when a crittur talks for talk sake, jist to have a speech in the paper to send to home, and not for any other airthly puppus but for electioneering, our folks call it 'Bunkum.'"

* * * * *

The dictionary shows that many well-known phrases are older than one might suppose. "Queen Anne is dead" cannot occur before Queen Anne's time, yet in her time there was an earlier version:

> "What news, Mr. Neverout?"
>
> "Why, madam, Queen Elizabeth's dead."—SWIFT, *Polite Conversation*.

Hobson's Choice may be earlier than the time of Hobson, the Cambridge livery-stable keeper, who refused to let out his horses except in strict rotation, to whom the phrase is usually ascribed. It occurred modified as *Hodgson's Choice* in a letter written as early as 1617.

A *fountain-pen* was described in France in 1658, and Fanny Burney used one in 1789. The slang word *wangle* dates from 1888. On the other hand, some phrases are startlingly modern, *journalism* (1833), *Tommy Atkins* (1883) (*Thomas Atkins*, a specimen name used in filling up Army forms, dates from 1815), *Tommy* (for the soldier) (1893), *week-end* became general about 1885, and the *nonconformist conscience* in 1890 at the time of Mr. Parnell's fall. *Motor-car* was used in 1895 (it was in November 1896 that a motor-car was first allowed without a red flag), and joy-ride in 1909.

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It is good to meet again words like *villain* and *prevent*, whose original meanings have been altered in time. There are others whose meaning has been distorted, owing to a misunderstanding of the source from which they came. The journalistic phrase "the psychological moment," meaning approximately "just the right moment," is due to a misunderstanding of the German *psychologisches moment*, the psychological *factor*. This phrase was used by a German newspaper in 1870 in reference to the anticipated effect of the bombardment of Paris on the *moral* of the besieged It has now passed, as the New English Dictionary put it, "nonsensically into English journalese."

It is curious that the phrase *the Pilgrim Fathers* apparently dates only from 1799. The Puritans who landed in 1612 at Plymouth Rock in Massachusetts were called pilgrims, not pilgrim fathers. It is a pity if this be true. Perhaps America can supply a quotation of the phrase which will save the situation.

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Professor Weekley has continued the Johnsonian tradition in allowing humour and cheerfulness occasionally to break through. Thus he describes *unquestionably* as a word which is used "in philology usually in reference to some hazy recollection of an amateur theory propounded in the correspondence column," and adds this quotation:

> "Dreyfus has nothing to do with 'tripod.' It comes unquestionably from the city of Trêves."—*Observer*, December 31, 1916.

Of *astrolabe*, after giving its derivation, he says, "Used in desperation by Swinburne," and gives the verse from *Poems and Ballads*. *Values* enables him to give Mr. H. G. Wells a little dig. Following its definition, are these two quotations:

> "We apologise to Mr. Wells for using the word 'values,' since he dislikes it.—*Times Lit. Supp.*, June 5, 1919.
>
> "The hooligan sees none of the values of the stranger. —H. G. WELLS, *The Observer*, January 18, 1920.

Under *mixed metaphor* he quotes the following from that well-known monthly magazine, *The Fortnightly Review*:

> "In 1914 our old regular army crossed swords with a great numerical superiority of the cream of the German host at concert pitch and undamaged by war."

It would be hard to beat this metaphor without mixing one up deliberately.

The word *serviette*, he says, is common in Scotland from the fifteenth century, but in England it is a late nineteenth-century refinement, now considered vulgar. He might have added, with propriety, the well-known quotation from *Punch*:

"No one mentioned in *Debrett*,
Talks about a serviette."

Yet if you are Scot, you may.

Under *Spoonerism* Professor Weekley gives the excellent "kinkering congs." A later one which may be new to some is the exclamation of an old man demanding assistance on a windy day: "Will no one pat my hiccough?"

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It remains to say a few words about slang. In this the dictionary is very properly well up-to-date, for slang has enjoyed greater licence and prestige of late years than at any previous time. "The slang of one generation," Professor Weekley remarks, "has often become the literary language of the next, and the manners which distinguish contemporary life suggest that this will be still more frequently the case in the future." Sport, the sea, Anglo-Indians, American story-writers, the cinema, the Stock Exchange, and the War have been fruitful sources of slang. *Cushy*, *blighty*, *pukka*, come from Indian languages. *To get it in the neck* appears to allude to "where the chicken got the axe." A playful variation is, "where Maggie wore the beads." This trick of dressing up old proverbs and phrases in modern clothes is chiefly American, and was used by O. Henry with great success. It can be very entertaining. Many of the War words will disappear from the language because the conditions that gave rise to them have gone. Others, like *stunt* and *gawblimey*, have been used so often that people are sick of them. A good deal of slang is self-explanatory—*cold feet*, for example; many phrases, such as *the Pragger Wagger* for the Prince of Wales, have simple explanations, if certain facts are known; but for many expressions no explanation has been suggested. Why is sixpence a *tanner*? and whence arose the phrase *the answer is a lemon?*

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This book should settle most of the arguments about words that one hears in railway-carriages or smoking-rooms, or reads of in the correspondence columns of newspapers and popular weeklies. Before consulting the dictionary, it might be well to write on a sheet of paper the phrases you wish to turn up. Otherwise, unless you are some kind of a Pelmanist, your attention will be led sadly astray by other words.

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Books on the Theory of Relativity still appear. Recently the whole of one issue of our contemporary *Nature* was devoted to an exposition of the theory, from fourteen points of view. Each contributor was assigned a task, and has endeavoured to say his say in as accurate and understandable a way as possible. Among recent books that have appeared are *The Theory of Relativity*, by Prof. R. D. Carmichael, of the University of Illinois (Chapman & Hall, 8*s.* 6*d.*), and the second edition of *Relativity, The Electron Theory and Gravitation*, by Mr. E. Cunningham, of St. John's, Cambridge (Longmans, 10*s.* 6*d.*). These books are for students. The most popular exposition is still Dr. Lawson's translation of Einstein's *The Theory of Relativity* (Methuen, 5*s.*), now in its third edition.

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Following Mr. Wordie's article of last month on polar exploration are two in this number, one on the Arctic by Dr. Rudmose Brown, the other on the Antarctic by Mr. Debenham. These three writers are well-known polar authorities. Dr. Rudmose Brown's article, dealing as it does with the Arctic, necessarily covers some of the ground described by Mr. Wordie; but there is much that is new and different, and a comparison of the views of men who have made not one only but several voyages to high latitudes is of interest.

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Several new journals dealing with the advancement of learning in their subjects have recently commenced or resumed life. *Photographic Abstracts* is a new quarterly published by the Royal Photographic Society of Great Britain. Its aim is to give to both the practical and scientific photographer a concise epitome of published work both at home and abroad. *The Antiquarian Journal*, two quarterly numbers of which have appeared, is the journal of the Society of Antiquaries of London. It should enlist the interest and support of the general public in touch with antiquarian matters. The Liverpool *Annals of Archæology and Anthropology* has resumed publication, a journal which had a distinguished career before the war.

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There are two books recently published which we wish to recommend whole-heartedly to readers. The first of these is *A Survey of English Literature*, 1830–1880, by Prof. Oliver Elton, of Liverpool,[1] and the second

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[1] Arnold. Two volumes, 32*s*

Queen Victoria, by Mr. Lytton Strachey,[1] the author of *Eminent Victorians*. We hope all libraries will get possession of copies of these books and that our readers will lose no time in reading them. An account of Queen Victoria will apear in these pages next month.

Antarctic Exploration in the Future

By F. Debenham, B.A.

Fellow of Gonville and Caius College, Cambridge

THE question is often raised, even in geographical circles, as to whether there is any field for further exploration in the polar regions now that both the Poles have been reached by man. Such a question discloses the extent to which the world has been led to believe that the poles themselves were important, and shows also how little is known of the less spectacular sides of polar work. It is answered very effectively by the fact that immediately after the discovery of the South Pole a large British expedition set out for the Antarctic, and that at present the first man to reach that point, Captain Amundsen, is occupied in an attempted drift across the North Polar Ocean. In both cases we may allow something for the fascination of the work itself, but we must also account for the support that is given by men who cannot go themselves.

The episode of the siege of the poles has now passed, leaving a wonderful tradition and stories of human bravery and endurance that are in themselves an asset to mankind. But now that it has passed, we can perhaps obtain a better view of polar work, and bring it into a more natural perspective. If we ignore for the moment the narratives of that siege, we shall find that the history of polar exploration is really the history of adventurous trade, one expedition after another setting out to find either new trade routes or natural resources, or even to develop polar industries themselves. And we may say at once that their aim has been achieved, that the world as we know it has profited well by its polar resources. A very brief inquiry into the profits of the Greenland whaling, or the Arctic fur and seal industry, or even the mineral deposits of Greenland and Spitzbergen, will show that they are far greater than the expense of finding those resources. In the lesser known Antarctic seas we already have a young and vigorous whaling industry which has produced a value of over twenty million sterling in the last decade.

Early in the nineteenth century a new type of story comes on the page of polar history, and together with the adventurous trader we find the adventurous scientist. One of the earliest expeditions of that type was the British one under Sir James Clark Ross, and its chief aim was the careful observation of magnetic data in the vicinity of the South Magnetic Pole, which was duly carried out. A rich harvest of geographical discovery was reaped at the same time. Since then we have had, and will continue to have, both types of expedition, or both aims in one expedition.

But whether it is the adventurous scientist or the adventurous trader that carries out polar work, we must emphasise the adjective rather than the noun, in other words, the impulse underlying either is adventure. Exploration in general and polar exploration in particular is an instinct, developed more strongly in some nations than in others perhaps, and it is to that instinct that we really owe the whole of our geographical knowledge. Reading our polar history from that inside point of view, we shall find it certainly instructive and often amusing to note how, in the preamble of objects before any expedition, the veneer of scientific or industrial reasons so barely covers the real impulse, the search for the unknown and the yearning for adventure.

The existence of this instinct is alone sufficient to vouch for a continuous future for polar work, for men will invent reasons for it or carry it out with no reason at all. It becomes then our business to see what good reasons there may be, to direct this impulse, as it were, into useful channels.

We can classify the aims of polar knowledge into three parts. There is the aim of the true geographer who yearns to fill in the blank spaces on his map, to know with reasonable certainty the outline and relief of every part of the globe. There is the aim of the merchant, the trader, and the miner to discover and develop all the natural resources of the world, whatever their latitude. There is the aim—a modern one—of the world scientist to complete his geo-physical data in high latitudes as well as in temperate and tropical regions. His immediate purpose may be the actual shape of the earth—geodesy—it may be the relation between the land masses—geology—or it may be any one of a number of sciences which depend on a complete knowledge of the earth's surface—meteorology, oceanography, earth magnetism, and others. If the first appeals to our sentiment, the second appeals to our pocket and the third to our brain and indirectly also to our pocket, for it must be remembered that what is the pure science of one generation is often the applied and industrial science of the next.

The first aim, then, is that of pure discovery, and we may turn to our maps to see what remains unknown.

In the South Polar regions, as a glance at the map will

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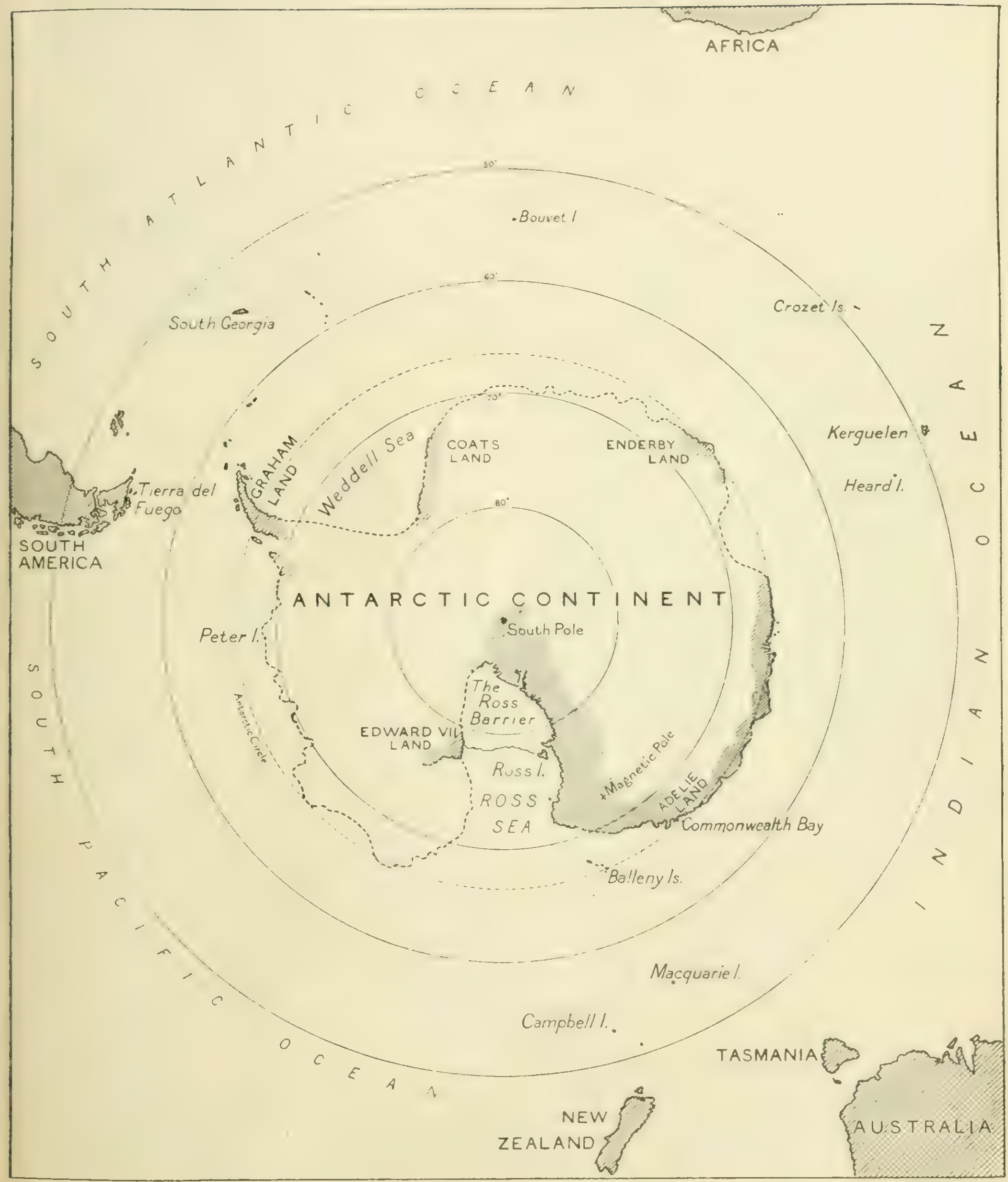
[1] Chatto & Windus, 15s.



Emery Walker Ltd sc.

show the extent of the unknown is far larger than in the north, and, in point of expense, more difficult of attack. We can be fairly certain that the area within the Antarctic Circle is mostly continent, and we infer also that it is for the most part very high land and ice-covered. But except in one sector, that to the south of New Zealand, we can hardly vouch for anything on land, for it has only been from observations taken from shipboard that we know of land beyond the circle. Two avenues of approach have been opened up in the past, and no new ones have been found or used. Ross in 1841 found that with a stout ship one could force the floating pack-ice which fringes the continent and penetrate far south in a comparatively open sea, since named the Ross Sea. That avenue has been used to reach the pole, as we know, but it has also given access to the continent for several expeditions whose object was mainly scientific, so that it remains the best-known part of the continent.

SHIP HELD UP BY THICK PACK ICE.
The [illegible] round the whole continent, which can only be [illegible] in wooden ships.

Another avenue exists to the South of Cape Horn in the form of a long tongue of land and scattered islands, apparently an extension of the main continent, reaching as far north as 63° S. lat. The credit of its discovery must be divided among many, but we may chiefly connect with it the name of Bellingshausen, the commander of a Russian expedition which sailed round the Antarctic continent in the early twenties of last century, a worthy successor to Captain Cook, who did the same fifty years before. Being a land avenue of a rather forbidding character, it has been hardly used for penetrating southwards, but nevertheless offers a path which will not be ignored in the future. To the east of the land tongue of Graham Land, as it is generally called, is the Weddell Sea, and this is regarded to some extent as an avenue comparable to the Ross Sea. More exact knowledge may confirm the sea in this character, but so far its reputation has been far from good. The sealer-explorer, Weddell, penetrated to 74° S. in 1823, it is true, and that without encountering any pack-ice; but those who have followed in his track have fared badly. The *Scotia* in 1904 equalled his record, but had to battle through much ice. The *Deutschland* in 1910 beat him by four degrees, but was beset by ice for many months and barely escaped. Lastly the *Endurance*, in 1915, had the same experience, but was finally crushed and its crew marooned on the ice.

There is therefore ample scope for purely geographical work in the South, and we may indicate some of the probable points of future attack.

As far as the coast-line of the continent is concerned, the greatest gaps are to the south of the Pacific Ocean, and to the south of the Atlantic—between Coats Land and Enderby Land. One would expect that these coasts would be finally plotted from circumnavigating ships, but in the case of the first there seems little possibility of doing it that way. Attempts have been made, both from the Ross Sea end and from Graham Land, to trace the coast in between. Scott in the *Discovery* did get far enough to determine the trend of the coast, and to see that only very powerful ships well supplied with fuel would be able to get far along the coast in that direction. The *Belgica*, under Gerlache, attempted the same thing from the other end, and was caught in the ice and drifted about for a year before getting free again.

The most promising method of attacking this strip appears to be by land parties using the sea-ice and fringing ice shelf for their route, and choosing their base in King Edward VII Land or Charcot Land. A landing has not yet been made on either of these places, but would be possible in the former in most seasons.

It is somewhat surprising that there has never been a determined attempt to follow up the discovery of Enderby Land by Biscoe, another whaling-explorer, in 1831. With the steam whaler there should be little difficulty in reaching the land there—Biscoe did not

TYPICAL ANTARCTIC SCENERY

Note the absence of bare rock except on slopes. Robertson Bay, South Victoria Land.

get closer than about five miles—and placing a land station from which land journeys might be undertaken. On the other hand, a ship in an open season might run in the coast much more cheaply and rapidly than any land party could hope to do.

There is another direction for land journeys which has not been followed since it was pioneered by Nordenskiold in 1902, and which offers a fair route for a long journey down the western side of the Weddell Sea. The coast is there flanked by a thick permanent sheet of ice which gives a good surface for travelling, and Nordenskiold had to turn back even before he had reached the Antarctic circle. An attempt to get well south along this route is being made this year by a small British party, who are being landed on the northern end of Graham Land by the Norwegian whalers who constantly hunt in these seas.

EMPEROR PENGUINS AND WEDDELL SEALS.

The only permanent inhabitants of the Antarctic foreshores. There are no land animals whatever.

The most important geographical problem of the South is the nature of the connection, if any, between Graham Land and the rest of the Antarctic continent; but there are many others of minor interest, such as the limits of the high plateau, the direction of slope and consequent movement of the ice sheet over it, the existence and trend of mountain ranges. It is, for instance, not impossible, though highly improbable, that there may be ranges of mountains comparable in height to the Himalayas still to be discovered in the heart of the great continent.

So much for the geographical secrets of the Antarctic; we turn now to consider its possible commercial future. The one industry which it can boast at present is that of whaling, and already the greater part of the world's supply of whale oil comes from the Antarctic and sub-Antarctic seas. Those seas are not yet fully exploited, and the Ross Sea, for instance, is quite untouched, although it is famous for its large schools of whales. If the need for animal oil continues, as seems probable, other centres for whaling will be opened up, and as long as the hunting is carefully regulated by law, the supply should be kept up perennially. Incidentally, much more information about the life-history of whales is required before such regulations can be properly planned.

On the continent itself there are no industries nor even the beginnings of one. Where there are no land animals there can be no fur industry, which is the great stand-by in the North Polar regions. There remains the prospect of finding payable minerals, and a great deal has been claimed for the future of such a vast continent in this respect. From what we know of the structure of the continent, we can say with assurance that there must be gold and other precious metals there. But whether they will ever be discovered in payable amount is very doubtful indeed. So far nothing but indications of copper have been found, though geologists have been on the lookout for ores in the few parts of the coast which have been visited.

The reason why there is very little chance of the probable wealth of minerals in the Antarctic ever becoming of use to man is that it is for the most part buried by a thick ice sheet which prevents it from being found, as well as providing difficulties if it ever were found. For the Ross Sea quadrant of the continent the proportion of bare to ice-covered land is about the same as the area of London to that of all England. Also the bare land where it occurs is often in the form of inaccessible cliffs. The search for gold will continue as a side-line for the prospecting geologists, but only the most unusual coincidence will unveil a deposit which would pay to work. The existence of coal of moderate quality has been established in two or three places, including the Beardmore glacier, only 300 miles from the pole, but naturally it is not likely to be profitably worked for a very long time to come.

The economic resources of the land itself, therefore, appear to be negligible judged by our present standards, though there is always the possibility of lucky finds which may give rise to small industries similar to the cryolite mines of West Greenland, a key industry to the production of aluminium.

There remains to us the third aim of polar exploration, the more strictly scientific one of completing our knowledge of world phenomena by observations in the Antarctic. Unfortunately, this is an aim which cannot appeal very greatly to the lay mind, for the value of such observations is not direct and may be long delayed.

In some of the brine wells of Southern China a new bore may take as long as sixty years to put down by the slow and laborious methods in use by the inhabitants. Yet a Chinaman will cheerfully commence such a bore, knowing that only his grandson can reap the profit from the work of two generations. Something of this patience and foresight is required in the prosecution of Antarctic research.

We can but briefly outline the necessity for such work, the final results of which it is almost impossible to forecast.

It is obvious that the weather, and particularly the rainfall, is of vital importance to mankind. If in some distant age it becomes possible for the weather prophet to forecast with assurance the next season's weather, the value to the agriculture of the world will be immense. At first sight that appears an impossible dream, but so was the conquest of the air less than a century ago. But if it is to be done, it can only be through the careful study of all the factors that go to produce our weather, and amongst these are the atmospheric conditions at the polar regions. Every schoolboy knows the importance of the equatorial belt as influencing the seasons and the weather, but few know that the polar regions act as a complement to that belt, and have an almost equal value in determining the weather. Until there is a vast amount of meteorological data from the polar regions, the problem cannot be properly set before the people concerned with it, and obviously such data can only be obtained by going and living there for long periods.

There are other branches of science which depend for a great part of their data on conditions at the poles, branches which must remain incomplete until someone goes and takes them on the spot. Terrestrial magnetism, for instance, is a property that we use in all navigation, and the world spends vast sums every year in following the vagaries of the magnetic needle and keeping its charts up-to-date. The earth as a magnet can be best studied at the poles of the magnet, and both of those are in the polar regions.

It would be possible but tedious to follow out the influence of those regions in half a dozen of the better-known branches of science, all of which are useful in a more or less direct way to mankind in general.

We may sum up the future of Antarctic exploration somewhat as follows: The first duty is to discover the limits of the continent and its main features, which demands several long sledge journeys and a good deal of ship work.

Concurrently with that there should be a definite co-ordinated attempt to investigate as fully as possible the various phenomena which have a bearing on conditions elsewhere, or are peculiar to the continent. This can only be done by the establishment of stations which can be occupied by the necessary parties of observers for long periods. Together with these definite problems come a host of minor ones, and also the continued though normally unsuccessful search for fresh resources which may be put to man's use. The economic aspect of exploration must be kept in view throughout, though in this case there seems little likelihood of any great discoveries being made.

In the past exploration has been carried out for the most part by private expeditions, which have done magnificent work and it is to be hoped will continue to do so. But there is a national and even an international aspect to the matter, and until that is fully recognised and an organised onslaught is made on the whole continent, a great part of the deeper scientific problems will have to remain unanswered.

BOOKS FOR FURTHER READING

The Lands of Silence. By Sir Clements Markham, K.C.B. (Cambridge University Press, 45s.)

This book contains accounts of the chief polar explorations, and gives references to the books dealing with the Antarctic. The *Geographical Journal* for March 1921 contains a lecture by the author on the future of polar exploration, delivered before the Royal Geographical Society.

Orthopædic Surgery

By A. B. Appleton, M.A., M.R.C.S.

Senior Demonstrator of Anatomy in the University of Cambridge

THAT special branch of surgery which is distinguished by the title "Orthopædic" is one of rapidly increasing scope and importance. This is largely an indirect result of the Great War, though actually dependent on new knowledge as to the behaviour of muscle and bone under altered conditions.

Previously concerning itself for the most part with deformities, especially those of children, it has now extended its sphere to include many conditions which are especially benefited by the application of its principles. Fractures are tending to become the special study of the orthopædic surgeon; tuberculosis of bones and joints is often now passed to him too, as one who must see to it that after cure there shall remain as little disabling deformity as possible.

Since, moreover, so much loss of usefulness in limbs was in the war directly due to injury of the nerves which control muscles, it has become necessary to develop the study of nerve repair, and of the muscular changes associated with injury to nerves.

The importance of rendering a wounded man as useful a member of society as possible is now realised as never previously, for the large numbers of the disabled render some solution of the problem of vital importance to the whole community. For the deformed in previous years pensions and institutionalism were the accepted fate; public opinion, indeed, conceived the man as helpless, and he in turn generally insisted on remaining so. Not but he sometimes found in his deformity a lucrative career. Witness the Court Fool or Jester. His lot, however, was a hard one; Christianity had brought a little amelioration, in almsgiving, but the Indians cast their cripples into the Ganges and the Spartans hurled them from precipices.

The problem of minimising defects and of educating the disabled to suitable occupations remained unsolved till this war. A start was made in 1914, by the Mayor of Lyons, who instituted the first training school for disabled soldiers; and somewhat later the need was met in this country by the establishment of large handicraft departments attached to special orthopædic hospitals. The combined "treatment and training" centres of to-day, administered by the Ministry of Pensions, represent our latest endeavours at providing a disabled man with a new and appropriate occupation, continuous anticipation of which is the duty of the orthopædic surgeon throughout the period of treatment.

Treatment, moreover, and training, are found to be of mutual assistance. Treatment gives far less satisfactory results if the recovering limb is not willingly and intelligently used by the patient.

The very earliest stages of the treatment of a wound have a profound influence over its future possibilities. It is hard in the later stages to undo the faults of earlier ones; and the unsatisfactory results attained when the time came to find occupations for the earlier war casualties led to the taking over by (Sir) Robert Jones of special responsibilities in the British Army for the cure of disabled limbs from start to finish. The United States Army was able to build where its colleague had laid the foundations, and from the beginning an organised attempt was made at the continuous supervision of men with injured limbs by expert orthopædists right from the line of battle.

Good ultimate function, is, then, the ambition of every surgeon engaged in orthopædic work.

The term "orthopædia" was employed as long ago as 1741 by Dr. Andry, Professor of Medicine in the University of Paris. His book on children's deformities received this title (from ὀρθός, straight, and *παιδίον*, a child), and in this he anticipated modern views in his belief in carefully selected exercises for the prevention as well as cure of certain deformities. He would thicken the sole of a shoe, attach a weight to a crooked shoulder or massage a hunchback, as a logical outcome of his belief in the evils wrought by a faulty posture. In France, in fact, was born a realisation of the importance of muscle action in the shaping of bones. Delpech was next on the scene. He was the scientific bedside observer; and from a study of his patients he was driven to the conclusion that deformities such as club-foot must be attributed to unbalanced muscular action. So we find him in 1816, at Montpellier, performing the pioneer operation of tendon-cutting, or tenotomy, by which he released the deformed part from the unbalanced pull of the more active muscle (the tendon or "leader" being the means of its attachment to bone).

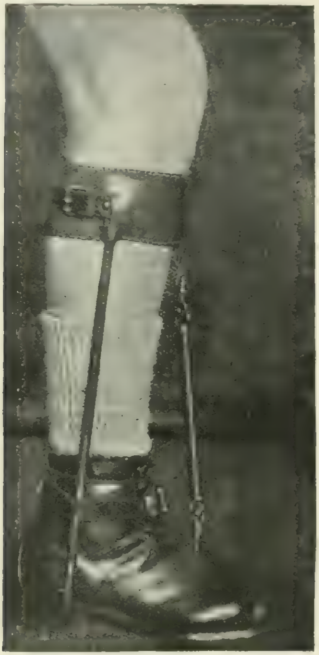


FIG. 1.

SPRING FOR DEALING WITH FOOT DROP.

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From its extreme simplicity, its great value, and the frequency of conditions in which such an obstacle to free movement is present, the operation with various modifications is still extensively employed. To-day, however, we must regard tenotomy in most cases merely as a remedy for conditions which were avoidable or preventable in the first place. Continued overaction of one set of muscles, with weakened muscles opposing it, brings about permanent shortening of the active set, and stretching with still further weakening of the less active; a vicious circle is established, and finally a fixed deformity of the joint is produced. Clearly the process should be recognised at its first inception, before definite secondary changes have occurred in muscles and neighbouring structures, and the onset of deformity should be prevented by support of the weaker muscles with splints.

A toe-raising spring is illustrated in Fig. 1, such as has been extensively employed for the prevention of deformity following foot-drop, a condition which occurs through injury of the nerve which supplies the toe-raising muscles. If such a case of foot-drop be left without support, the heel becomes more and more drawn up till eventually it gets fixed there by the shortening of the active calf muscles, and at this stage tenotomy above the heel must be an essential preliminary to any attempts to cure the toe-raising muscles.

To return to Delpech, we find that he had many imitators, and Stromeyer of Hanover was able, by adopting his idea, to relieve squint by division of certain eye muscles.

German surgeons next made a great forward step with the introduction of osteotomy—the division of bone by saw, or by hammer and "osteotome" (like a chisel with double bevelling)—a procedure by which the fragments may be made to unite in any desired alignment. It provides a means of placing the lower limb in a useful position, when, for example, hip disease has culminated in a fixed updrawn thigh. And other similar circumstances arise, the commonest being, perhaps, bending of the bones under the body-weight from rickets.

To-day an alternative procedure (osteoclasis) for children of three or four with the bent legs of rickets consists in simply breaking the bone across by hand without incision. But it is, of course, less exact. And though it appeals to some parents as being "bloodless," it is quite inadmissible when the "bend" has occurred near a joint. So-called "bloodless" methods, in fact, must be reserved for suitable cases, and each case must be judged on its merits. While it succeeds with the dislocated hips of little girls, it involves the gravest risks in old-standing shoulder dislocations. We may consider, then, that since the advent of Listerian Principles in Surgery, there is no reason whatever for avoiding the knife when better results are thereby obtained than by other means.

Consideration of the normal functions and requirements of the lower limb, and the contrast presented in these respects by the upper limb, which is not a supporting but a prehensile organ, has led to differentiation of the treatment meted out to the two limbs for similar injuries, or diseases. Mobility in an elbow is eminently desirable, whereas a fixed straight knee is of far more service than an uncertain movable one; indeed, an arm is rendered useless if the elbow becomes fixed in any position but a right angle (or near to it), and even then it is a poor imitation of the intact arm. Procedures (arthroplasty) have now been devised to restore mobility to a fixed joint where this is thought to be desirable; a new joint is fashioned and a flap of the soft tissues, muscle or fascia, is interposed to prevent reunion of the separated bones. Again, when required, anchylosis (fixation) of a joint may easily be brought about by the removal of a slice from the end of each bone, which bones are then steadied against one another till they have united; and in the lower limb such a procedure saves the child with paralysis from the need for wearing heavy and expensive apparatus to steady the joints.

A wide choice of operations, then, is now available for the treatment of joint and bone troubles; for the final selection from these special experience in these conditions is necessary if the maximum of usefulness in the limb is to be ultimately attained.

Fractures have recently been tending to fall within the special province of the orthopædic surgeon. A great variety of principles has in the past been adopted in their treatment.

At one time they were kept severely immobilised till union was assured. Later, Championnière advocated movement and massage to obviate the stiffness which invariably followed from want of use of muscles and joints. But except where this treatment was carried out by his own specially trained masseuses, it was unsuccessful, because satisfactory union of the fragments was so difficult to attain. It is now recognised that close and correct apposition of the fragments does take precedence over all other considerations, but that at the earliest feasible moment, slight movements should be commenced—and the earlier the better; but no success in the preservation of healthy muscles and joints compensates for such a mechanical disability as a badly-set ankle.

Owen Thomas, the founder of the Liverpool School of Orthopædic Surgery, made a great advance when he devised the splints which bear his name for knee, hip, and arm, consisting of wire frames to steady the limb while yet permitting of an unimpeded circulation. Splints fashioned on this principle are to-day in widespread use; it will be seen what free access there is to the injured limb for the provision of massage and other active treatment.

The methods of Thomas were those of one who had discovered by 1880 the faults of the surgeons of his time, who gave insufficient rest to the limb; and one, further, who had perceived the fallacy of "manipulations" as practised by eminent bone-setters, and indeed previously by himself and his own father. These splints are of the greatest use for the control of the more awkward fractures, and with recent improvements are extensively employed.

Thomas's splints do not, however, provide for active movement of the injured part; and nowadays it is possible by various devices to provide suitable movements for injuries (including fractures) at a very early date. Especially is this necessary for a good result after an injury close to or involving a joint. Temporary support can be provided in a variety of ways until there is a minimal consolidation of the repairing tissue (known as callus). This may be by means of sandbags; or merely by strapping; or a plaster of Paris encasement may be prepared to fit, e.g., the leg for ankle fracture, with a hinge behind so that one side of the calf muscles may receive attention while the other side is supported by the splint. A recent method of preserving the health of neighbouring muscles in such cases as these is described later; the method, that of "graduated contractions," can be applied to the injured leg, even while this plaster splint is still being worn.

We find thus a germ of truth in the teachings of both Championnière and Thomas; one of them guarded against subsequent stiffness due to neglect of muscles and joints; the other ensured sound if slow bone repair.

A radical method of assisting bone repair, mechanical fixation with plates and screws, or with wire, was advocated and practised originally by Sir Arbuthnot Lane. Only possible with the advent of Listerian surgery, it is even now limited to *healthy* limbs; soiled wounds necessitate complete healing before such an operation can be considered, owing to the extreme susceptibility of living bone tissue to the poisons produced by bacteria. This embedding of metal is inferior to one of the recent developments of bone-grafting: the employment of bone inlays which unite the two fragments. As compared with old-fashioned methods of treating bone-fractures, however, it was reported in 1912 by a commission of the British Medical Association that, for adults, Lane's method of fixation of the fragments was the most successful, but that in children better results were attained either by immobilisation or by mobilisation with massage. A considerable number of cases was investigated: 2,596 treated by immobilisation; but only 147 treated by operation were at that time available. The growing bones of children are liable to severe injury under surgical procedures, the growth being liable to much retardation or distortion; and for this reason all types of bone-operation are generally avoided up to the age of about seventeen.

The recent tendency has been to reserve these operative procedures for cases where reapposition of fragments is very difficult to *maintain* in any other way; even the Liverpool school, which usually attains reapposition by powerful traction, and retention by Thomas's splints and their adaptations, finds scope for operative fixation where one fragment is small and uncontrollable—in their striving after true apposition and correct alignment.

A recently-introduced method of obtaining small muscle movements, suitable for maintaining a healthy condition during enforced rest, as immediately after a fracture, or again during the period of loss of power from nerve injury, consists in "treatment by Graduated Contractions." It is possible to obtain so small a contraction that the tendon merely stands out prominently without even producing a movement of the joint; and any required force of contraction may be provided with the greatest degree of accuracy. Such a method is obviously of the utmost value in maintaining muscles in good condition; for it is in *active use* that muscles find their best restorative; and it can be applied when it is still undesirable to allow of any joint movement, as in the early steps of treatment of a fracture. Contractions obtained by this method closely resemble ordinary voluntary movements. By this method, however, a *single* muscle can be made to contract, a feat which is extremely difficult of performance, and without practice almost impossible, under ordinary voluntary power. Any weakened muscle can thus be singled out for attention. A further advantage is that a small contraction is obtainable when none at all can be obtained by voluntary power; it can therefore be used to pave the way in a recovering muscle for movements of a voluntary nature.

It must be added that Graduated Contractions, graduated as to force with a scientific accuracy by the specially-trained masseuse, are greatly superior to *voluntary* contractions which are of much less certain force and amplitude, and are likely to do more harm than good in a recently injured limb.

It was by the recent elaboration after prolonged experiment of a special faradic coil that such Graduated Contractions have been made possible. The stimulus from the *ordinary* faradic coil is painful, and the patient inevitably resists. The coil which succeeds is practically painless in that it provides a secondary current of very low voltage, and that it has a perfectly regular action of the interrupter. The intensity of the stimulus is varied at will by pushing in or withdrawing the soft iron core which is found in the primary coil here as in an ordinary induction coil.[1] It may be noted in passing that the electricity is not employed for any general effect it may have on the body, but entirely to obtain the graduated muscular contraction which is the end in view. It is applied at certain spots on the skin of the limb, known as "motor points," of which there is approximately one for each muscle.

Slight cases of weakness in a muscle may be remedied by exercising this special muscle against such a resistance as a skilful masseuse can supply with her hand; and this method always becomes supplementary to Graduated Contractions in the later stages of muscle recovery; obviously, however, it is not available with a paralysed muscle; and, as mentioned above, it is an undesirable method of maintaining muscle tone when recent fractures or severe joint injuries are present.

The muscle-wasting which occurs in an immobilised limb, and which occurs much more markedly when the nerve or a neighbouring joint has been injured, has been in the past extensively treated by massage. Since, however, this does not in itself involve any active contractions, it is a very inferior procedure for the purpose in view. Massage acts directly on the circulation of the part and reflexly through the nervous system; it is suitable for quite another class of disorder. Passive movements, i.e. movements performed by the masseuse, who holds the limb, are also inferior in that active contraction of the wasted muscles is not an essential part of the procedure.

How very important is the procedure of graduated contractions will be realised when it is also recalled that in every case of joint injury there is severe muscle-wasting. Community of nerve-supply is responsible for a sort of "symbiosis," if we may borrow the term, between joint and closely associated muscles; if, for example, the knee-joint is affected, extreme wasting is liable to occur in the Vastus Internus, the muscle which forms the swelling just above the knee on the inner side.

Championnière aimed at avoiding muscle-wasting and stiffness of the tissues during the treatment of fractures by "active" means—movement and massage. Now we are achieving, better than ever before, some of the results at which he was aiming, with the great advantages we now possess in delicate modern instruments for obtaining small muscle contractions, such as the specially wound induction coil mentioned above.

That muscles require such minute care during the treatment of a fracture is probably one of the chief considerations which is leading to the transference of such injuries to the orthopædic surgeon.

[1] See W. Rowley Bristow's book quoted at end of paper.

Many other unsatisfactory after-results of old-fashioned methods of treatment of injuries such as sprains, dislocations, etc., are attributable to the lack of care for the muscles during the process of recovery. A man, for example, is laid up for three weeks with a sprained ankle; he gets up, finds his foot "weak," and develops a flat foot. The fact is that the muscles supporting his instep have so far wasted that they are unequal to their task; the ligaments, next feeling the strain from the superimposed body-weight, give way, and the arch of the foot drops. Occurrences like these will become rarer and rarer, just as stiff limbs after fractures are becoming less common, in proportion as the newer principles of treatment become more widely understood and practised. There is not yet the same wide acceptance of the principle of early movements in the case of fresh sprains; many eminent orthopædic surgeons have adopted it, realising that here, as in the case of fractures, it is the extent and force of movement which determine disaster or success.

Treatment by graduated contractions with increasing amplitude of movement of the sprained joint, for twenty minutes daily, serves admirably to maintain muscle health and hinder the adhesion of the various tissues. All this at a stage when voluntary movements would be painful and quite inappropriate. For these fresh sprains there is, of course, everything to be gained by employing massage, also, for the removal of fluid in the swelling and for the alleviation of pain.

Sprains of "joints" (i.e. really of ligaments) and sprains of muscles are much relieved if the obvious procedure be employed of preventing tension on the damaged structure. The realisation of the value of this we really owe to the Liverpool school, and, like all Owen Thomas's methods, it is attained by quite simple means. At the ankle, the object can be achieved by "crooking" the heel with a ½-inch wedge of leather on one or other side; but a "rider's strain," which under treatment by massage and strappings may prevent hunting for one season after another, is often amenable to nothing but a course of graduated contraction for the damaged muscle.

Of favourable terminations to acutely *inflamed* joints (as after penetration by a sharp instrument or projectile) anchylosis is at present commonest. While much more crippling in the upper than the lower limb, the limb may still be fairly useful if union of the two bones occurs in a favourable position. Intelligent anticipation in these cases as to the probable course of the case becomes of supreme importance; should a shoulder be likely to anchylose, it must be kept from the side at an angle of about 45°, a position in which, even with complete anchylosis, considerable and useful movements will be possible by movement of the shoulder-blade with arm in one piece.

Better than any anchylosis, or subsequent procedures such as the arthroplasty already mentioned, will be a method which aims at primary cure of the inflammation with a *movable* joint. Colonel Everidge has applied for inflamed (septic) joints a principle somewhat analogous to the employment of graduated contractions for muscles. Movements insufficient to cause injury, but adjuvant to the normal processes of repair, are obtained by an ingenious arrangement of pulleys (Fig. 3), very slowly and steadily moved by the running of sand through the balancing weights; and movable joints result where immobilisation would inevitably have ended in anchylosis. Belgian surgeons have obtained similar successful results; but further experience is necessary to determine the scope and limitations of this promising procedure.

The employment of X-rays is of great value in orthopædic surgery as in general surgery, but especially so because so much of the surgery of bone falls within the sphere of the orthopædist. Recently the regular employment of X-rays has revealed the fact that many supposed sprains are complicated by fractures which would be unrecognisable by other methods of diagnosis. Previously there had been extreme uncertainty as to the prospect of good ultimate cure in these "sprains"; the assistance thus provided by X-rays is rendering far easier the determination of the proper date at which, for example, weight should be permitted upon an ankle, sprains and fractures being so different in this respect. Wrist and finger "sprains" are, it has been discovered, frequently complicated by such unobtrusive fractures, very disabling, however, when treated by too prolonged rest or, on the other hand, by too early and too vigorous treatment.

For watching the fate of bone-grafts, for studying the condition of bones and their relationship to surrounding parts, the use of X-rays has been one of the chief factors in the recent progress of bone-surgery. Adhesions, whether between joint-surfaces, between tendons and the sheaths within which they run, or between muscles and surrounding structures, are all the result of immobilisation, of lack of the natural movements of the part. Three weeks of this treatment will incapacitate a healthy knee: how full of risk, then, when neighbouring injuries have occurred, with their associated swelling, and processes occur which prevent absorption. Adhesions are liable to form after unrecognised injuries of the joint surfaces from small complicating fractures. After the lapse of time, movements become less painful, but in certain positions the pain is still liable to occur from tugging upon the fibrous band into which, by repeated movements, the adhesion has been stretched. Now, the recognition of these adhesions is sometimes difficult, but the importance of their diagnosis is beginning to be realised; for by complete rupture of adhesions, relief is obtained; by incomplete rupture, the condition is only aggravated through the injury inflicted. Hence, to borrow a formula of the old bone-setter, Hutton, in speaking of deranged knee-joints, "pulling is of little use; it is the twist as does it." The long history of that ancient British practice "bone-setting," with which was associated in former days the practice of the "professional rubbers," teems with examples both of success and disaster following the same methods of treatment. The method of treatment was, in fact, regarded as a personal or family secret, so that we can appreciate what it meant to Hutton when he imparted to Dr. Peter Hood (who gratuitously attended him in an illness) all the secrets of his art. After Hutton's death in 1871, Dr. Wharton Hood, the son of Dr. Peter Hood, following the usual practice of the medical profession, made public all he knew of the art, as exemplified in Hutton's methods, and he showed how Hutton profited by the failure of so many of the medical profession of his day to gain a real understanding of joint troubles.

(*To be continued.*)

BOOKS OF REFERENCE OR FOR FURTHER READING

(1) *Treatment of Joint and Muscle Injuries.* By W. Rowley Bristow. (Oxford University Press, 1917, 6*s.*)
(2) *Menders of the Maimed.* By A. Keith, M.D., F.R.C.S., F.R.S. (Oxford University Press, 1919, 16*s.*)
(3) *The After-Treatment of Wounds and Injuries.* By R. C. Elmslie, M.S., F.R.C.S. (J. & A. Churchill, 1919.)

The Optophone[1]

By Edward Cahen, A.R.C.Sc., F.I.C.

Blindness, and all that it means, has always provoked more sympathy than any other deprivation to which man is subject, and of all the tragedies of war, perhaps the greatest is the sudden veil of darkness which has descended on so many of our soldiers and sailors. Marguerite Radcliffe-Hall[2] has endeavoured to express the consolation of inward vision supposed to be possessed by the blind in a song which has been set to music by Robert Coningsby Clarke:

"Set my hand upon the plough,
My feet upon the sod:
Turn my face towards the east,
And praise be to God!
Ev'ry year the rains do fall,
The seeds they stir and spring;
Ev'ry year the spreading trees
Shelter birds that sing.
From the shelter of your heart,
Brother, drive out sin;
Let the little birds of faith
Come and nest therein.
God has made His sun to shine
On both you and me;
God who took away my eyes,
That my soul might see."

Exquisite as is the sentiment expressed in these few beautiful lines, they offer but little practical help to the sightless, who, no longer being able to read, are deprived of one of the greatest consolations in suffering and trouble it is possible to imagine.

Up to the present time, the only way in which the blind might read was by feeling the letters in specially embossed books. These books, printed in the Braille system, were a great boon to blind readers, but this method of printing books was not only cumbersome, but also very costly, and reading was a very slow process. The optophone, which was invented by Dr. E. E. Fournier d'Albe, of London, in 1912, and has been since modified and developed by Messrs. Barr & Stroud, of Glasgow, has successfully overcome these disadvantages. The optophone enables a reader to read ordinary printed matter, such as books or newspapers, by listening to the letters in a telephone. As the instrument traverses a line of print, each letter produces in the telephone receiver a series of musical notes forming tunes or musical motifs. As the majority of blind people have a good sense of hearing, it is not long before each letter in the alphabet is identified with its musical motif in the receiver, and in this way the words and sentences formed from the letters can be read. When the sound-alphabet has been learned, the more extended motifs for syllables and even words becomes familiar to the reader's ear. Just as a telephone operator can interpret easily a succession of clicks on the Morse code, so the optophone reader recognises words in his instrument. Already it has been found with the latest type of optophone that a blind reader after some practice has attained a reading speed of twenty-five words a minute. This is, of course, a slow speed compared with the rate at which we read, but it is an extremely hopeful one. The ideal optophone would be an instrument which sounded the very letters of the word read, or the words themselves, but this instrument has still to come. Meanwhile, the blind man may read by means of the musical motifs.

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[1] The Editor wishes to thank Messrs. Barr & Stroud, of Glasgow, for their kindness in furnishing him with the illustrations in this article and for their courtesy.

[2] *Songs of Three Counties and Other Poems.* (Chapman & Hall, 1913.)

The principle upon which this instrument is based depends upon the vagaries of the substance selenium, an element which is closely allied chemically to sulphur, with which it is often associated in nature, and which is regarded as an unmitigated nuisance by the manufacturer of sulphuric acid, because it spoils his acid for use in the paper-making industry. Selenium was formerly obtained as a waste product from the lead-chamber process of making this acid, but it is now obtained almost exclusively from the electrolytic smelting of copper, which is carried on chiefly in the United States. The fact that is made use of is that the electrial conductivity of selenium in one of its physical forms varies greatly in accordance with the amount of light which falls upon it. This was first noticed by Willoughby Smith and his assistant May, who were carrying out some cable-testing experiments on the Island Station Valentia, off the coast of Ireland, in the year 1873. May could not get the results from his instruments by day to agree with those by night. He therefore came to the conclusion that there must be something peculiar in the way this element selenium behaved when an electric current was passed through it. It had long been noticed that selenium offered a very great resistance to the passage of the current, but it had not been observed that *the degree of resistance was affected by the amount of light falling on it.* It is this peculiarity of selenium that is the basis of the optophone.

Writing to a friend early in 1873, Willoughby Smith tells of his discovery in rather a witty and graphic manner:

> "With the assistance of a microphone one can hear the footsteps of a fly as loudly as if it were the tramping of a horse on a wooden bridge; but it strikes me as much more wonderful that by means of a telephone I can hear a ray of light falling on a metal plate."

When light falls upon selenium prepared in a special way, a change takes place in its conductivity, and this change occurs almost instantaneously. It is the rays at the red end of the spectrum which are most efficient in bringing about this change. The conductivity is nearly double in sunlight what it is in the dark. When the source of light is removed, the drop in conductivity occurs very rapidly.

To get the maximum effect from a small amount of material, the selenium must be prepared in a special form. Great ingenuity has been displayed in attacking this problem. Graham Bell, the inventor of the telephone, was the first to make a reliable selenium cell, as it is called, though Werner Siemens three years earlier, in 1875, had made an attempt. Presser in 1909 first produced one of the up-to-date cells, and Fournier d'Albe followed with his two years later.

Presser's cell consisted of a circular piece of steatite (a silicate of magnesium) covered with platinum and engraved in concentric rings. The whole surface was then covered with molten selenium. Fournier d'Albe's cell is simpler still, and far less costly. He uses a small plate of unglazed porcelain about one inch square; this is covered with graphite, and then engraved in fine grooves from side to side, close together, and slightly inclined, like the one in Fig. 5 below. The whole is finally coated with molten selenium, with the exception of a small margin on each side to serve as the electrodes. These natty little structures have received the distinctive name of selenium tablets from their originator. They are very strong, and cannot easily be damaged; furthermore, owing to their small size, they can be suitably mounted in any way for the purpose in hand. It is a modification of these little tablets that is the actuating principle of the optophone.

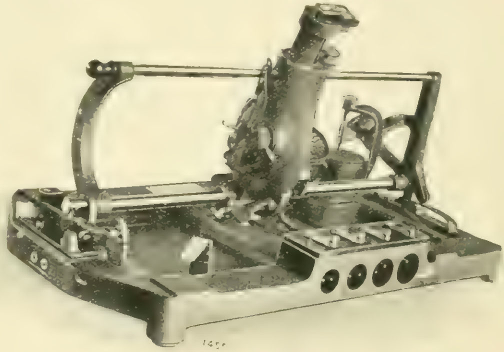


FIG. 1.
THE OPTOPHONE WITH BOOK-REST REMOVED.

Now, if an ordinary telephone receiver be connected in series with an electric battery and one of these selenium tablets, a current will pass through the tablet, and the current will vary as the light falling on the tablet varies, since this alters its conductivity. The tablet is called a "selenium bridge." When flashes of light are thrown on to the selenium bridge at a rate of 256 per second, the current will rise and fall at that rate, and the telephone will sing out the note middle C of the piano. If the pulsations of the light are at half that frequency, that is, 128 per second, the telephone will sing out C an octave lower, and, with double the frequency, 512 pulsations per second, the C one octave higher, and so on. The rate at which these pulsations are sent out can be varied as required, and so a note agreeable to the listener may

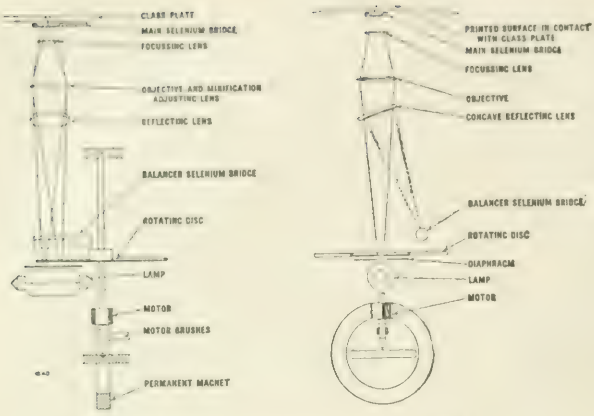


FIG. 2. FIG. 3.

DIAGRAMMATIC ARRANGEMENT OF OPTOPHONE.

be obtained. These are, of course, well-known facts. It is the rôle played by the selenium which is the novel feature.

In the optophone a selenium bridge is exposed to successions of sets of light pulsations, which vary according to the forms of letters as these are passed over in traversing a line of printed type, each letter being indicated in the telephone by a characteristic motif comprising successions of single notes and chords. And the letters of this sound alphabet can be readily learned.

The optophone is quite small, not much bigger than a portable typewriter, and externally (Fig. 1) there is not much to be seen, just a glass table on which the book or other printed matter rests face downwards. To understand the mechanism of the machine, the reader must glance at the diagrammatic views of the mysteries hidden away under this table. Each letter is illumined in turn by the light which is thrown up from beneath, and which is made to travel along the lines of print by a specially designed variable speed governor. The source of light is a small straight electric filament lamp (Figs. 2 and 3), the rays of which are made to pass through a diaphragm on to a perforated disc (Fig. 4), which is caused to rotate rapidly by means of a small magneto-electric motor driven from secondary cells. The light which passes through this disc is directed by suitable lenses on to the printed page, and traverses an aperture in the selenium tablet which is placed directly under the glass table. As this tablet travels along with the rest of the optical apparatus to which it is attached, it catches the light diffusely reflected from the white paper surrounding each letter in turn. This the makers call the "main selenium bridge," to distinguish it from the "balancer bridge," the object of which will shortly be explained. Both these bridges are shown in their various stages of production in Fig. 5. The graphite areas are simply pencilled on, leaving the "lane" of bare porcelain between. The tablet, or bridge, is afterwards smeared with selenium paste and annealed. The actual working principle of the instrument is as simple as it is ingenious: the light which passes the five rings of perforations in the rotating disc falls on the printed matter as five dots in a row, and is known as the "scala" (Fig. 6). Each spot pulsates at a rate corresponding to the number of the perforations in the particular circle to which it belongs, multiplied by the number of revolutions of the disc per second. The circles are provided with 18, 24, 27, 30, and 36 holes respectively, from the centre outwards. The pulsations of each spot of light are translated into a definite musical note in the telephone attached, the pitch of the note varying according to the speed at which the disc is rotating, but the intervals, which are those between the notes G, C[1], D[1], E[1], G[1] (soh, doh, ray, me, soh), remain the same, whatever this speed may be. There is a focusing arrangement which adjusts the width of the scala to the size of the print, so that as the scala passes over the type, combinations of the musical notes are given out, forming a motif which is peculiar to each letter, and which can be heard in the telephone connected with the main selenium bridge as mentioned above.

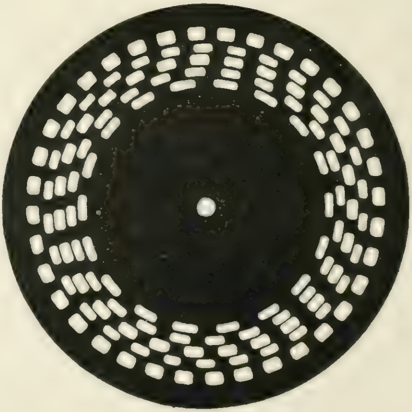


FIG. 4.
ROTATING DISC.

In this instrument all the notes are sounded at once, producing discord when a sheet of white paper is laid on the table, and on the contrary there is dead silence in the telephone when a piece of black paper is substituted for the white. If the scala passes over the letter V, for example, the top note (high soh) will first be silenced, then me, ray, doh, ray, me, and soh in succession. Such an instrument is therefore referred to as a "white sounding optophone," for the reason already explained, that it is the white spaces around the words which form the musical motifs. The newest optophones have been so modified by the introduction of the balancer bridge, of which we have already spoken, so as to "sound black."

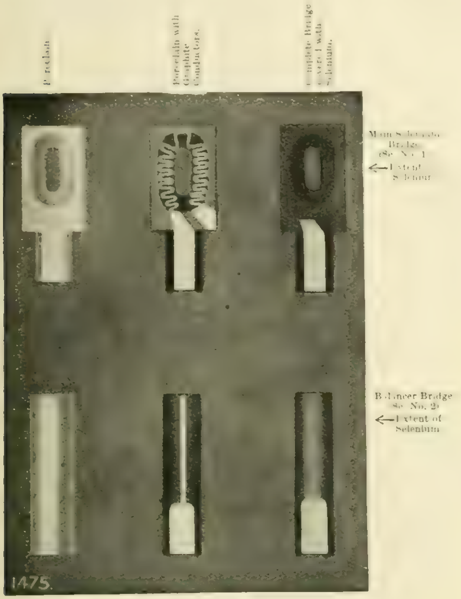

Porcelain
Porcelain with Graphite Conductors.
Complete Bridge covered with Selenium.
Main Selenium Bridge (Se. No. 1)
Extent of Selenium
Balancer Bridge (Se. No. 2)
Extent of Selenium
1475.

FIG. 5.

In this case white paper produces silence in the telephone, and each black letter has its own musical motif, which can be distinguished and learnt with much greater ease by the blind reader, as they are far more characteristic than the motifs produced by the white spaces surrounding the letters in the older type of machine. With this instrument the letter V is represented by the motif soh, me, ray, doh, ray, me, soh.

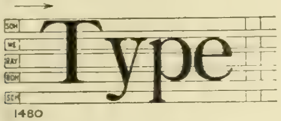


FIG. 6.
SCALA PASSING OVER PRINTED LETTERS.

How the two selenium bridges are connected to the battery and telephone is seen at a glance in Fig. 7, and the working of the balancer is explained by the makers in a booklet on the optophone, published by them, from which I have quoted, and from which they have kindly allowed me to reproduce the various figures illustrating this article. "The balancer is illuminated by a small part of the intermitted light reflected aside before it reaches the paper, and is so connected to the telephone and battery that the current traversing the balancer bridge acts in the reverse direction in the telephone to that of the current through the main selenium bridge. The balancer thus tends to cause the telephone to sound all the notes continuously, and the main selenium bridge, that receives the light reflected from the paper, annuls the effect on the telephone in respect to any note when the spot of light corresponding to that note falls on white paper. The division of the total voltage of the battery can be varied, so that when the whole scala falls on white paper, the telephone is silent, and notes are sounded only as the scala moves over the black letters."

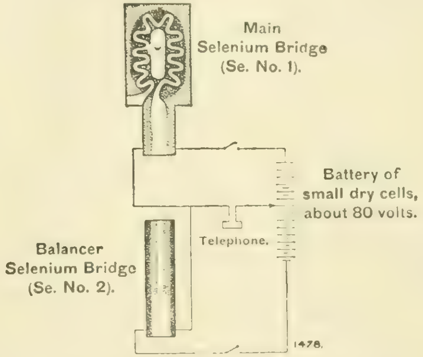

Main Selenium Bridge (Se. No. 1).
Battery of small dry cells, about 80 volts.
Telephone.
Balancer Selenium Bridge (Se. No. 2).
1478.

FIG. 7.
DIAGRAM OF SELENIUM BRIDGE CONNECTIONS.

One of the finished instruments was shown at the Scientific Products Exhibition at the Caxton Hall in the summer of 1919, and since then the optophone has become quite a feature of all exhibitions where British post-war industry is to be seen. It seems a fitting atonement that a firm which formerly devoted itself to instruments of precision for use in warfare (the range-finder, for example), should make an effort to upon the [illegible] that war has created, for, needless to remark, the optophone is being used to offer some consolation and relief to those officers who have lost their sight in their country's service.

Further information on this subject may be obtained from a booklet [illegible] gratis in May, 1920, by Messrs. Barr & Stroud, Ltd., Anniesland, Glasgow.

Problems of Arctic Discovery

R. N. Rudmose Brown, D.Sc.

The attainment of the North Pole in 1909 by the late Admiral Peary has not, as some people idly suppose, put a check on Arctic exploration or in any way lessened the desirability of its continuance. The result of that fine feat of organisation and endurance has been to turn exploration into less sensational and so perhaps less popular channels, but at no period since the date of Peary's success have the Arctic regions been deserted by explorers. Canadians, Americans, Danes, Norwegians, and Russians have done a remarkable amount of successful work during the last decade, and now Sir Ernest Shackleton proposes to use his long Antarctic experience in the solution of certain Arctic problems.

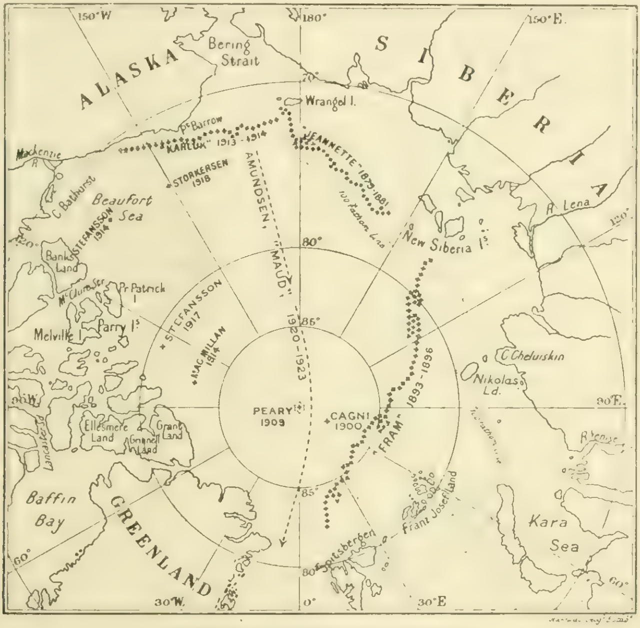
During the years 1908 to 1918, V. Stefansson and his staff were busy exploring the western islands of the Canadian Arctic Archipelago, discovering several new ones and amplifying and correcting earlier charts. Americans under D. Macmillan from a base at Etah in north-western Greenland, from 1913 to 1917, did much work in Ellesmere Land, touching on Stefansson's sphere in the south-west. Erichsen, Mikkelsen, Rasmussen, Koch, and other Danes have continued the fine record of Danish explorers in Greenland, and almost completed the mapping of the coasts of that island. Russians have most successfully re-explored the north coasts of Siberia and adjacent islands, making considerable changes in the map and accomplishing, in Vilkitski's voyage in 1914–15, the second traverse of the North-East passage and the first on record from east to west. Lastly, to mention only the outstanding achievements, Roald Amundsen, the Norwegian discoverer of the South Pole and the first navigator of the North-West passage, made the North-East passage in 1918–20 and arrived safely in Alaska, only to leave again for the north to emulate with his vessel, the *Maud*, Nansen's drift in the *Fram*, hoping to pass across the heart of the Arctic Ocean.

While scientific research in geology, meteorology, magnetism, oceanography, and other sciences is the most fruitful aspect of exploration, it must be remembered that no modern expedition, properly staffed and equipped, ignores these sides of its work, even if its main task is to penetrate the areas which are still blanks on the map. The scientific results of an expedition are the most important, but they fire the imagination less than the discovery of new lands, and after all, eager as the explorer is to probe the problems of his special science, the lure of the unknown and the spirit of adventure are the prime motives that send him to his quest. Those of us who have been fortunate enough to take part in such work know quite well that adventure pure and simple, and not scientific curiosity, led us first to polar regions. On a recent occasion Sir Ernest Shackleton very truly said: "One goes out mainly for the adventure of it, and to hide oneself behind the cloak of science is not quite honest."

It might appear that, in view of the expeditions mentioned above and the work of the previous century, there is little discovery to be done in Arctic seas, even if a great deal of careful exploration is required. But that is not the case, and fortunately for the adventurous spirits who find their fascination in polar regions, there are still certain areas of the Arctic Ocean which may hold hidden islands, and in any case afford ample difficulties for the ambitious explorer who seeks to traverse them.

With the exception of the *Fram* and the *Maud*, all exploration of the Arctic Ocean has been conducted by advances more or less successful from ships or land bases. The aim generally was to have a land base as far north as possible, and hence Spitsbergen, easily accessible, Greenland, and even Franz Josef Land, were favourite starting-points. It was by using Cape Columbia in Grant Land, almost the most northerly land known, as a base from which to make a dash of 826 miles to the Pole and back that Peary achieved success. Attempts of this nature, previously all directed to the Pole itself, left on one side the Arctic Ocean north of Alaska and eastern Siberia through 180° of longitude. No land is known in a high latitude on that side of the Arctic Ocean. There are other contributory reasons for the neglect of this area. It is inaccessible to ships except by Bering Strait or the difficult and uncertain North-East passage, and in consequence lies far distant from the enterprising exploring nations of the Atlantic sea-board, circumstances that are now modified to some extent by the opening of the Panama Canal. Furthermore, the narrow and shallow Bering Strait, by excluding the warmer waters of the Pacific, results in the ice-bound sea extending much farther south on the Siberian and Alaskan than on the European and Atlantic sides of the Arctic Ocean.

The *Maud*, imprisoned in the drifting pack-ice which sets with the current towards Greenland and Spitsbergen, will probably cross the heart of the polar basin, advancing approximately along the meridian of 180°. But between that longitude and the Parry Islands there remains a vast area north of about lat. 74° N. that has never been entered, unless perhaps some unrecorded American whaler has seen his chance in an open season and pushed north. Roughly speaking, this may be termed the Beaufort Sea, although that name is more strictly applicable only to its south-eastern part. This will prove a difficult region to explore. Stefansson maintains that what he calls the pole of inaccessibility in the north lies in lat. 83° 50′ N., long. 160° W., that is, 370 nautical miles from the geographical pole on the meridian which passes about 80 miles west of Alaska's most northerly cape. The drift tactics of Nansen and Amundsen might be tried, but with less hope of success than farther west, at least until more is known of the currents. More than one whaler caught in the ice has disappeared in this sea never to be heard of again. De Long's *Jeannette* in 1881 and Bartlett's *Karluk*, the latter destined in 1914 to explore this sea as part of the Stefansson expedition, both drifted westward and northward in the southern part of this area of the Arctic Ocean until crushed in the ice. (It must be remembered that neither was built of sufficient strength to withstand heavy ice-pressure.) Stefansson, in crossing the south-eastern end of the Beaufort Sea, found a continuous south-westerly drift. Other evidence is in favour of an easterly set which packs the ice against the Parry Islands, Grant Land and Greenland. More than one explorer has penetrated 100 miles or more into this region from the land to the south or east, but there is space for large islands to be hidden in this unknown sea. What is the likelihood of land existing there? On the whole very little. The few soundings taken north of Bering Strait and Alaska are in favour of a narrow continental shelf and a sea floor falling rapidly to the great depths of the Arctic Ocean, although west of the Canadian Arctic Archipelago the evidence is less conclusive. Evidence deduced from the drift of the pack-ice and the course of the tides is also opposed to the existence of land in this area. Keenan Land, vaguely reported from whaling sources in the seventies of last century, was practically disproved by Storkersen's sledge journey from the coast of Alaska to lat. 73° 58′ N., long. 147° 50′ W. in 1918, and Crocker



SKETCH MAP OF THE POLAR REGIONS

Series of crosses mark drift of ice-bound ships; single crosses indicate farthest advances into unexplored area of Arctic Ocean between Alaska and the North Pole. The probable course of Amundsen's drift is shown.

Land reported by Peary in 1906 to be some 150 miles west of Grant Land, could not be found by Macmillan in a sledge journey in 1914. Dr. Cook's report of land on the same meridian in lat. 85° N. can scarcely be taken as evidence of its existence. Nevertheless, that stretch of Arctic Ocean offers a fine field for the pioneer explorer.

Another but much smaller area of the Arctic Ocean that should be examined for possible land lies between Spitsbergen and Franz Josef Land, from lat. 80° N. to 84° N., the so-called Victoria Sea. There is more than one report of high land sighted in that region, of which the least unconvincing was that of the late Admiral Makaroff, of the Russian Navy. When testing the ice-breaking qualities of the *Yermak* in 1899, Makaroff went north of Spitsbergen in search of heavy ice, and in the course of his cruise reported high land seen in refraction at a distance of 60 to 100 miles, on about the thirtieth meridian and in about lat. 82° N. Curiously enough, this is about the locality to which Giles Land, discovered in 1707 but not explored till nearly two centuries later, was unaccountably displaced by Petermann, the German cartographer, from its true position some two degrees farther south. The pack-ice drifting from the north-east makes this part of the polar sea difficult to penetrate, but quite possibly some Norwegian hunting sloop in a favourable season has crossed it. There used to be a rumour among the walrus hunters of a large island to the north-east of Spitsbergen, but the story lacked substance and was generally discredited. The existence of islands at one time reported north of Franz Josef Land has been disproved, but at the same time the occurrence of small islands east of Spitsbergen and the extension of the continental shelf a short distance north of Spitsbergen shows that there is nothing intrinsically impossible in hidden islands existing in this sea. On the other hand, there cannot be much land between the meridians of western Franz Josef Land and eastern Spitsbergen, owing to the freedom with which pack streams southward on the east of the Spitsbergen archipelago and its speed of movement north of Franz Josef Land. The northward extension of Nikolas Land, north of the Taimir Peninsula, Siberia, requires further investigation. The unexplored area of the ocean north-east of Greenland, which offers little likelihood of land, will probably be visited by Amundsen on his present expedition.

Apart from the task of penetrating the ice-bound seas, other difficulties not quite so obvious present themselves.

It is possible in polar regions to be very near land without seeing it. Fog may be a hindrance, but even in clear weather it must be remembered that the horizon is at no great distance from the deck of a small ship. If the sea is clear of ice there is probably no lookout in the crow's-nest and low land might escape detection. A most striking and almost incredible instance of an elusive land is the little-known Nikolas Land, which lies north-west of Cape Chelyuskin, the most northerly point of Siberia. Several exploring vessels on the lookout for land had rounded this cape, including the *Vega* in 1878 on her circumnavigation of Asia, and Nansen's *Fram* in 1893, but reported only sea to the north. Great was the surprise, therefore, when the Russian ice-breakers *Vaigach* and *Taimir*, under Com. Vilkitski, in 1913 discovered a considerable extent of high land and two small islands some thirty miles north-west of Cape Chelyuskin. This discovery shows that it is unsafe to remove a reported land from the map merely because it has escaped rediscovery by vessels or sledging parties in the vicinity.

The Russian ice-breakers in 1913 and 1914 crossed the position of the reported Sanrikov Land to the north-west of the New Siberia Islands and saw no land. The *Fram* in 1894, passing on the west, failed to sight it. We are probably justified in saying that it does not exist. Yet a snow- or ice-clad land may merge so effectively into a background of cloud as to be almost invisible. Every voyager to and from Spitsbergen knows how Bear Island, full on his track, eludes his view despite its height of 1,760 feet. On the other hand, nothing is commoner in polar seas than the appearance of land which on closer examination turns out to be a cloud or mirage effects. Even experienced polar voyagers are thus deceived at times, while the novice discovers new land every day.

It must not be forgotten that many doubtful lands have been reported from a great distance and placed by one bearing which, even if the compass is accurate and the magnetic variation known, is at best an unsatisfactory way of locating a position. Distance in polar regions is very deceptive. In fine weather the transparency of the atmosphere is so marked that long distances appear quite short and, provided the land is high enough, it can be seen 100 miles or more away with great ease.

The methods of Arctic exploration have changed since the days, not half a century ago, when weak-powered vessels contested with the pack-ice, and large sledging parties heavily laden with stores and dogged by scurvy made heroically laborious marches into the unknown. Dogs were rarely used, although Wrangell a century ago showed what could be done with them. Even after Rae showed the advantage of travelling with small parties and making use of dogs, the practice of man-hauled sledges persisted. Sir Leopold M'Clintok, a pioneer in successful Arctic sledging, was one of the few explorers to follow Rae's example until the days of Peary and later Scandinavian explorers. The marvel is that these early expeditions achieved so much, burdened and hampered as they were in their movements. Their achievements speak volumes for skill in seamanship and high endeavour and great endurance in travelling. Dr. John Rae, the discoverer of the fate of Franklin and his men, had great success as an Arctic sledger, because he utilised dogs for traction, and depended largely on the game the country provided. Thus he was enabled to travel light with small parties, and succeeded in covering great distances at high speed with a minimum of exertion. Large parties are at a disadvantage whether the provisions are carried or obtained by hunting on the way. Nansen, in his fine journey from the *Fram* to Franz Josef Land in 1895, travelled with one companion, and during their wintering the two lived on little else than the produce of the sea.

Peary was a believer in small parties, but his practice of carrying with him practically all his provisions necessitated a system of supporting parties. His dash to the Pole in 1909 was at an almost incredible speed: sufficiency of food and lightness of load could be combined only through speed. Sverdrup, Isachsen, and other Norwegians did notable work by small parties with dog sledges. It was left for Rasmussen and other Danes in Greenland, and particularly Stefansson in Canadian Arctic islands, to perfect the method of "living by forage" and travelling light in small parties. So successful has Stefansson been by these means that he has been able to stay long periods cut off from a base without suffering any inconvenience. Even tea, coffee, and tobacco are dispensed with. On one occasion Stefansson left the shores of Alaska to cross the south-east of the Beaufort Sea, a journey which took him 96 days, with two weeks' provisions, but suffered from no lack of food. To him the seal is a source of food and fuel, and he has shown that their numbers have no direct relation to latitude. They are frequent in most parts of Arctic seas, even if "ice deserts," places devoid of seals, occur, and necessitate a dash to escape starvation unless some reserve meat is carried. Not only does this method of living immensely lighten the explorer's task, but also it prevents all risk of scurvy, and Stefansson has shown that an exclusive meat and blubber diet, even without salt, is in no way harmful to health or destructive of powers of endurance.

While Arctic sea-ice on the whole lends itself to sledge travelling, because of the land-locked nature of the polar basin, there are great difficulties to be faced which in places are almost insuperable, as many an early explorer found to his cost. Open lanes of water may always be encountered, especially near the edges of the pack where the ocean is widest, but are relatively unlikely off the Parry Islands, Ellesmere Land, Grant Land, and Greenland. Pressure ridges are great obstacles near land, especially north of Greenland. But most troublesome of all is the drift of the pack which in some parts is so considerable that no journey against the drift is likely to make headway. In 1827 Parry had to abandon his attempt to attain a high northern latitude by sledging north from Spitsbergen, because the southerly drift nullified all his efforts; and in 1900 Cagni, on his return from his northern record, lat. 86° 33′ N., had great difficulty in regaining his base in Franz Josef Land owing to the drift carrying him to the south-west.

On the other hand, advantage can, of course, be taken of the drift in planning a journey, now that its general direction is known. It is in this way that the most successful explorations of the Arctic Ocean have been made, as in the case of the *Fram*. Amundsen in the *Maud* should turn up near Greenland in two or three years' time.

Ice-breakers have some small value near the edge of the pack, but experience has shown that they cannot penetrate far, and are unable to make much impression on ice of several years' growth. For several seasons Russian ice-breakers explored the Siberian fringe of the Arctic Ocean, but were unable to escape the necessity of either wintering ice-bound or retreating in autumn.

For a discussion of V. Stefansson's methods of exploration, see his articles in the *Geographical Review* (New York), especially October 1918, May 1919, and September 1920. Reference should also be made to a recent article by F. Debenham: "The Future of Polar Exploration," *Geographical Journal*, March 1921. For trustworthy accounts of the history of polar exploration the best books available are—(Arctic) *Handbook of Polar Discoveries*, A. W. Greeley (Boston, 1907); (Antarctic) *The Siege of the South Pole*, H. R. Mill (London, 1905). Later works do not equal these in completeness and accuracy.

Plant Hygiene

By George C. Gough, A.R.C.Sc., B.Sc.

Blights and pests on plants are no new things, and they are mentioned in the earliest books on agriculture and horticulture, but little or nothing was known as to their cause; in fact, they were looked upon as a visitation of God.

The term "blight" is still commonly used in a general sense, although, nowadays, it is chiefly applied either to attacks of "green fly" or to ordinary potato disease. In the country it was by no means uncommon for dull, misty days to be looked upon as caused by blight, and the natural corollary of this view was that nothing could be done to save a crop when it was [illegible] an attack of blight as if it were in such an amount as to darken the air. The east wind also gets credit for bringing "blight," and this is no new idea. Witness the blasting of the ears by the east wind in Pharaoh's dream.

When, however, some knowledge of the life-history of the various pests and diseases found on plants was obtained, attempts were made to check at least the damage done. At an early date various poisons were used as insecticides, such as solutions made by soaking tobacco or by dissolving soap, and the accidental discovery of "Bordelaise" gave an impetus to spraying generally.

Bordelaise, or Bordeaux mixture, as is well known, was first used to cover grapes growing alongside paths and roads to prevent "finger blight." It was discovered, however, that vines treated in such a way were free from attacks of mildew, and the habit of spraying the whole of the vineyards with this mixture of blue vitriol and lime became general. Later it was found that it not only prevented attacks of mildew on vines, but many other diseases caused by fungi on plants generally. Nowadays it is commonly used to prevent attacks of ordinary potato disease (Phytophthora).

With the increase of spraying, came the development of spraying machines for distributing the fluids, originally put on in a primitive way by sprinkling it on the plants with a brush of twigs. Nowadays a big industry has sprung up, and all kinds of machines, from small hand-pumps suitable for an amateur's greenhouse, to large complex motor-tackle for use on farms, are produced. In addition, numerous firms have specialised in the providing of suitable sprays and washes, and other material connected with the checking of plant pests.

Old growers frequently say that there were not so many pests in their young days. As a matter of fact, most of the pests abundant at the present time were present, but not in sufficient numbers to attract the ordinary growers' notice. On the other hand, there has been an increase in the opportunity for the spreading of such pests. Half a century ago, orchards were scattered and few in number. Since then, especially in certain districts such as Kent, Wisbech, and Worcestershire, the planting of fruit trees has gone on to such an extent that orchard meets orchard for miles, while plants have been collected from all countries. It is, therefore, not surprising that pests which were confined to isolated districts, with a limited amount of food material, made the most of their opportunity. The great increase of food plants enabled them to perpetuate themselves on a large scale. Coincident with this, nurserymen and others have introduced plants from abroad with their respective pests, and in many cases the pest has not been content to remain on its original food plant, but has adapted itself to other varieties, so that new pests on our native plants have been introduced. In some instances, good examples being American gooseberry mildew and wart disease of potatoes, these pests have made the industry a precarious one, and great losses have been incurred.

Growers on a commercial scale have been passing through a period where pests were unheeded until obvious damage was done, and have then attempted to check or kill the pest by spraying. The latter will still be necessary, but nowadays efforts are being made to lessen the labour involved by a little forethought on the part of the grower. He is finding that it pays him to learn the life-history and appearance of the enemies of his crops, so that he can not only recognise them at an early stage in their existence, but also know the most vulnerable point in their life-history. Such knowledge tells him that general untidiness and carelessness in the orchard and field means the propagation and protection of his enemies. Hence the science of Plant Hygiene is coming into being. "Prevention is better than cure" applies here as elsewhere.

As an example of the help given by a knowledge of the life-history of a pest, that of the winter moths might be quoted. These moths, as their names imply, are in the moth or adult stage during the winter months, and they are singular in having females which are wingless, or practically so, and which therefore cannot fly. In order to lay their eggs they have to climb up the trees, and most trees are a prey for them. Up-to-date growers take advantage of this stage to place around the trunks of the trees a band of parchment paper on which a thick and sticky grease is placed. If properly done, the moth is unable to pass over the band, and is caught there. Each moth would lay from two to three hundred eggs, a large proportion of which would hatch out to the familiar green caterpillars that so frequently eat the trees bare in the spring and early summer. Where this grease banding is not done, the alternative is to allow the moths to lay their eggs. These hatch in due course, and the trees are then sprayed with a poisonous wash in the spring, so that in eating the leaves the caterpillars also partake of their share of the poison, which is usually arsenate of lead.

The necessity for dealing with pests either by the method of prevention or of cure is realised when one considers the amount of damage such pests can do to the food supply of the country, and it is no exaggeration to state that on an average, approximately one-tenth of every crop is lost annually through one or more diseases or pests. Frequently this percentage rises considerably, for example, when one gets a "blight year" amongst the potatoes, and it is not unusual for farmers in such a year to lose at least half, if not more of their crop. What this means in figures can be calculated by considering the acreage of potatoes only in 1920. This is reported as 544,000 acres, and the crop should average out at 5,440,000 tons at the rate of 10 tons the acre. In all probability it will be somewhere approaching 3,264,000 tons, which is at the rate of 6 tons per acre, the average crop usually grown in England. Much of the loss is due to preventable causes.

In America, the land of big figures, the Codling Moth (the parent of the maggot in apples) is stated to cause an annual loss of nearly 2,500,000 tons, and the Cotton Boll Weevil costs Texas cotton-growers over £5,000,000 annually. A wilt[1] of tomatoes caused a loss of 50 per cent. of the crop in one State, while the loss in other States varied from 10,000 to 25,000 tons. Here future losses may be checked, as a wilt-proof tomato plant has been obtained. In the Laredo district of Texas a tiny "fly," known as a "Thrips," reduced the tonnage of onions which were exported by 20 per cent., and in Kansas in 1916 it was estimated that 250,000 acres of oats and 100,000 acres of wheat were destroyed by the "green bug." Even greater losses were sustained in Oklahoma, and it is added that "a good part of this infestation could have been prevented by a proper entomological procedure."

There is another side to the picture. The universities of California, as a result of work on a caterpillar pest of the peach, produced in one year an increase of 500 car loads of peaches, and from Holland comes the statement that as a result of the general use of grease-banding to control the winter moths, as mentioned above, £10,000 is put annually into the pockets of the Dutch fruit-growers. It is very difficult to get at the cost of checking pests, but a case from California is quoted where a severe attack of caterpillar was found on grapes. Here the system, which consisted of spraying the vines with arsenate of lead and nicotine, was applied for seventeen days, and the cost of materials, labour, and apparatus was £2,200. This was less than 4 per cent. of the net return, as the crop which was saved was estimated by the owner as being worth £60,000.

It is therefore obvious from such figures (and many more could be enumerated) that there is great scope for preventive measures in the growing of crops, although there is little hope of ever getting the full theoretical crop from any plant, because the cure of one disease frequently gives another disease or pest an opportunity of establishing itself. Still, by general hygienic methods many plants would be saved to provide food which otherwise would be wasted.

The word "Hygienic" connotes cleanliness, and townsmen, with visions of a farmyard and its frequently unsavoury contents, wonder where it comes in. In this connection, however, it means the general tidiness of fields and plantations, and the disposal of refuse therefrom. Quite a large proportion of the pests of the growers have to find a resting- or hiding-place from one season to another, or until the time when their particular fancy in the way of sustenance again grows on the field where they are. Their opportunity arises when the grower leaves the refuse of the crop lying about, whether it be on a farm, garden, or fruit plantation. On this the pest remains sometimes merely hiding, but more often in a resting stage, such as the pupa of an insect or the resting-spore of a fungus. Thus stubble will contain thousands of pupæ of tiny flies, which will ultimately be ready to attack a similar crop in the same field or one near-by. It is to obviate this that the farmers seldom follow a crop by a similar one in or near the same field (rotation of crops). It is, however, apparent that if the farmer could collect up and burn his stubble, he would burn up also its many thousand unwanted guests. In practice this is not deemed possible, and the usual alternative is to plough in and bury the stubble deeply so that flies cannot make their way out of the ground. This, however, is far from being effective. Fruit-growers for the same reasons should cut out the dead and dying wood from their trees and burn it promptly, for it is on this that many of their enemies breed. Thus one disease of plums, known, because it causes the leaves to become silvery, as "Silver Leaf," propagates itself only on dead wood. Consequently, the removal and burning of such wood is a hygienic method of protection, and this is now compulsory, plum-growers being required under a penalty to remove all dead wood each year before April 1.

Many diseases of plants, especially of root vegetables and potatoes, are caused by fungi,[1] which spend their resting-period in the soil. Here, again, the leaving of vegetables infected by such diseases to rot on the ground means the releasing of thousands, nay, in some cases, millions, of spores into the soil to await the arrival of a fresh crop in a succeeding year. And wait, they will, in some instances for ten years or more. Sometimes such vegetables as infected turnips, potatoes, etc., are fed raw to animals so that they shall not be wasted—only to get back to the land, and frequently to a clean field, with the manure, for the spores pass through the animals unchanged.

Numerous similar examples could be given, all testifying to the value of prompt destruction of refuse, but these must suffice.

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[1] The withering and death of a plant.

[1] A lowly group of plants, of which the moulds on moist bread, cheese, jam, etc., are examples, and which propagate themselves by minute bodies called spores, which act like seeds.

Mention, moreover, should be made of weeds. These are not only injurious directly by crowding out the proper plants and robbing the soil of food material,[1] but indirectly to a greater extent by acting as hosts for injurious pests and diseases which might otherwise starve before their normal food-plant was growing again in the field.

Growers are also by no means blameless as regards introducing a pest or disease to their crop. Thus fruit-growers buy trees that are infested with various pests which, by a little care and attention, could be got rid of at an early stage. Seed is sown which carries with it the spores of certain diseases, and plants like cabbages are bought which introduce diseases into hitherto clean soil. Of course the nurserymen or seedsmen are also to blame in such cases, and very shortly it will become an offence to sell plants or seed seriously affected with certain scheduled diseases. Many such diseases could be prevented by treatment at an early stage. Thus, cereals suffer frequently from a disease called smut, which causes the ears to produce sooty-like masses in the place of the grain. Suitable treatment of the seed by chemicals, such as formaline or blue vitriol (copper sulphate), will prevent this, and up-to-date farmers always "dress" their seed before sowing.

The prevention of disease by planting varieties which are immune from, or resistant to a disease, has been dealt with before,[2] and little more need be said. Although of partial application only, as the resistance is only to specific diseases, it can be used where a particular pest is rampant, and a crop obtained notwithstanding its presence.

"Dodging a pest" is also practical in some instances. Certain pests can work only within certain limits ot temperature, moisture, etc., and if these are known, an attack may be prevented. Thus the early sowing of oats may prevent an attack of the frit fly, which causes much loss, and the late sowing of wheat in the autumn may save a field from attack by one of its parasites. Space prevents further illustrations, but one may conclude with a few words on prevention by preservation of a pest's parasites. The obvious case is the protection of insectivorous birds which feed on insects, the greater proportion of which are injurious. Besides these, there are smaller enemies of insect pests, such as the ladybird-beetles and their larvæ, or "niggers," as they are called; the larvæ of the lace-wing or "golden eye," and the larvæ of the hover-flies, which, as their name implies, hover over flowers; all of which feed voraciously on "green fly" or aphis. The hover-fly larva is a greasy-looking, elongated maggot with tiny head and no legs, and it has a very business-like way of picking up green fly, sucking them dry, and casting away the skin in a very short space of time. A few minutes' observation of one of these will show what effective aids they are to the grower. In America special attention is paid to the breeding of ladybird-beetles, some of which feed on scale insects and mealy bug as well as on aphis, and they are released where they will do the most good. Yet other insects, even smaller, are parasites, in or on the pests of plants, and these super-parasites, as they are called, help to keep in check many pests.

To sum up, growers of all kinds of plants are nowadays finding it much easier and cheaper to prevent pests by killing them in their early stages, when they are vulnerable, than to attempt to combat them by spraying when they have come to maturity and the damage has been done.

What is the Nature of the Unconscious Mind?

By Joan Corrie

AT this time, when the new psychology, or psycho-analysis, as it is generally called, is not only in actual use as a method of curing neurotic ailments, and a system of re-education for people who, from whatever cause, have failed to adapt themselves suitably to life; but also is made the subject of letters to newspapers, sermons from the pulpit, and discussions at afternoon tea, it may be of interest to try and examine in a simple and non-technical manner how the new psychology differs from the old, and what is the nature of the material with which it works.

Psycho-analysis differs from academic psychology in two very important particulars. First, it is *individual* instead of being merely collective. We used to learn how—all brains being made on the same pattern—all men think and feel and act. Psycho-analysis lifts the individual out of this generalisation and says to him, "Though specifically human in type, and so conforming to the laws which govern human thought, feeling, and action, yet because this one particular mind belongs to you, and not to A or B or C, therefore it is unlike all other minds, and is as individual and unique as your features, which yet as parts of a human face are possessed by everyone."

In the second place, academic psychology is almost entirely concerned with conscious processes, whereas the new psychology is concerned with that infinitely larger part of the mind which is the subject of this paper, the *Unconscious*.

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[1] DISCOVERY, February 1921.

[2] See article on "Immunity and Plant Diseases," DISCOVERY, June 1920, p. 197.

We may begin by asking, What is the unconscious? Quite simply, the answer is that it comprises everything that is not present to consciousness at any given moment. Round about the immediate objects of consciousness there is a semiconscious fringe which may at will become the focus of consciousness, so that on this level there is a shifting interchange between the conscious and the unconscious. For example, we will suppose I am engaged in balancing my weekly accounts. My conscious thought is concentrated on that, yet I am not entirely unaware of the room in which I sit, of some slight physical discomfort, of the fact that it is growing dark, and so on. If I choose, or even without my will, any part of this fringe can force itself into a more prominent position and displace my conscious focus. But below this lies an intangible barrier known as the " threshold," beneath which we come to the unconscious.

There is a well-known illustration by a noted author of the human psyche as an iceberg. Above the surface of the water a small portion—about an eighth—is visible, but the vast bulk lies below the waves. With this illustration in our minds let us attempt a short exploration, imagining a vertical shaft or passage through the iceberg. We have passed through the upper part representing the conscious mind, and we find ourselves below the threshold, or, in this case, the water. We are in the submerged part of the iceberg. What do we find there?

First, we find *Memories*. In the topmost layer, if I may so express it, we find our recent memories, the happenings or the thoughts of a day or a year ago. Most, probably, of these can be recalled with an effort, though many have sunk deeper and cannot be remembered. But as we penetrate further, we find that our whole life, as comprised in thought, word, deed, or event, has been preserved and is intact. A fraction of this mass can on occasion rise into consciousness, for the threshold is permeable and admits from below whatever is able to come up; but on the lower levels we find the forgotten past which does not and cannot rise, because it has been repressed from the conscious mind, either intentionally or in obedience to its own laws. This is the material which reappears in dreams and phantasies, usually in a disguised and symbolic form.

Secondly, we find *Phantasies* in the unconscious. These are chiefly concerned with desires which have no opportunity of being gratified in the conscious life, either because their nature is incompatible with the moral standard of the individual, or for lack of opportunity. These memories, phantasies, desires, do not lie in the unconscious like mud or débris at the bottom of a pool. On the contrary, they are living and active forces influencing the person's conscious life without his knowledge or will, and at times they can be animated by a terribly destructive energy causing neurosis, obsessions, and insanity itself.

This part of the unconscious is called by Dr. Jung, the leader of the Zurich school, the Personal Unconscious, because everything contained in it is to be found in the person's own life. Its chief characteristics are its infantility and its compensatory character.

The personal unconscious is infantile in nature in so far as it contains repressed materials, because our whole education is intended to make us " put away childish things," and we put them into our unconscious. The primitive, the child, and the unconscious think in the same way—by analogy. This is like That, therefore This is That, and is represented symbolically as such in the dream. Our childish passions, jealousies, wishes, outgrown in our conscious life, are to be found here. Above all our childish phantasies, our own private myths, are in the unconscious.

The second chief characteristic is compensation. Whatever value or lack of value is to be found in the conscious, its opposite is in the unconscious. Every individual possesses the germ at least of every human quality, but the aim of our civilisation has been to develop certain of these which we have elected to call " good," and repress others which we call " bad." Hence the compensation of the unconscious which tends to equilibration. Is a given individual a saint outwardly? If so, he has probably exaggerated certain qualities by the process of violently repressing others, which below the threshold maintain a life of their own disturbing to sainthood. Or has he given the rein to every desire and vicious impulse in his outward life? In that case, the lost values are below. In whatever direction the conscious life is one-sided, the unconscious tips the beam in the opposite one. Of course, the ideal is the mean in which conscious and unconscious act together in harmony, making one-sidedness impossible. It is not true that psycho-analysis, by bringing up from the unconscious material which, *while it is there*, is harmful to the individual, thus lets loose instincts and passions, to the great danger of the individual and of society. It is surely better that the saint, for example, should know by experience that he shares in the tendencies of the sinner, and, while controlling them, learn to live with them humbly, than that they should affect him from within unknown and unsuspected.

This short exploration of the personal unconscious by no means exhausts its nature, but we must hurry on into what lies around and beneath. We are now at the lowest point of our submerged iceberg, and our next step takes us out of it into the fathomless ocean. This is Dr. Jung's Collective Unconscious. It is the Great Mother Unconscious of us all, into which we come at birth, and out of which we slowly and painfully differentiate our own individuality. We find in it our family characteristics, then our ancestral and racial peculiarities, and finally the qualities of primitive man and of his forebears the animals. All instincts, human and even pre-human, are here, all the fundamental thoughts and ideas peculiar to man from the very constitution of his mind, all the gods and all the devils, all that has been in the past, and all the possibilities of the future for the individual, and for the race through individuals. Everything is here in the collective unconscious, and when the barriers are down, anything is possible, anything may rush in to the conscious mind, to the immense enrichment of the individual's life, or—if he has not learned to navigate this illimitable ocean—to his absolute undoing.

In closing, one last characteristic must just be alluded to. The unconscious is the great generator and reservoir of psychic energy. The principle of the conservation of psychic energy seems to hold like that of the conservation of energy in the physical world. Each person has a stock of energy which is constantly transformed, but never diminished or increased. It is always actively creative, and beneficent or injurious according to the use to which it is put. As long as it is in contact with Reality, whether objective or subjective, it is constructive. But turned back upon itself, and only engaged in creating the phantastic and unreal, it destroys, for it then begets neurosis, disease, insanity, and even death itself.

BOOKS FOR FURTHER READING

Collected Papers on the Psychology of Phantasy, by Dr. Constance E. Long. (Baillière, Tindall & Cox, 10s. 6d.)

Analytical Psychology, 2nd Edition, by C. G. Jung, M.D., LL.D. Edited by Dr. Constance E. Long. (Baillière, 18s.)

Psychology of the Unconscious, by Dr. C. G. Jung. (Kegan Paul, 25s.)

Dream Psychology, by Dr. Maurice Nicoll. (Oxford University Press, 6s.)

The Interpretation of Dreams, 7th Edition, by Dr. Sigmund Freud. Translated by Dr. A. A. Brill. (Allen & Unwin, 1[illegible]

Reviews of Books

Government and People. An Introduction to the Study of Citizenship. By CONRAD GILL, Reader in Constitutional History in the University of Birmingham, with the collaboration of Professor C. W. VALENTINE. (Methuen, 7s. 6d.)

What proportion of the adult population of this country could say off-hand when a parliamentary session normally begins and ends, what the common law is, what a district council does or may do, what is the significance of votes of supply, appropriation bills, and grants in aid, how long the police system has been at work, or how the Consolidated Fund is managed ?

This sort of knowledge, and much more, ought to be part of the stock-in-trade of everyone who claims the rights of citizenship. But at the present time most people have only a shadowy idea of the way in which public business is carried on : consequently they are at the mercy of the few—journalists, officials, politicians, financiers—who have taken the trouble to learn something about government. Even these few are often more interested in party wire-pulling than in studying the public welfare. If only a moderate proportion of the voters had a fairly clear idea of the way in which they were governed, political progress—carrying with it a good deal of social progress as well—would be incredibly swifter than it is. Above all, if we knew the *possibilities* of government—the unused powers of promoting public health, education, town-planning, agricultural development, and the like—they would be so stirred with the vision of England as it might be, that they would never rest until the vision had become a reality.

Some of these possibilities are suggested in the chapter of *Government and People*, which deals with "The Aims of Government." It is shown that the three great aims are security, justice, and liberty, and that in all these lines the sound policy is continually to screw up the minimum standards—whether of material welfare, knowledge, or conduct, the final aim being the opportunity of a full life for the whole people.

But the authors are careful not to lay too much stress, or to repose too much hope, on the work of government. They argue that the impulse of progress must generally be sought among the people rather than the rulers ; and, in common with many modern thinkers, they look upon the State as only one of many organisations that keep society together, and help it forward—or backward as the case may be. The main reason is given on p. 279 :

"Nearly all changes are due to new ideas, whether in art, religion, philosophy, science, poetry, politics, trade, agriculture, or any other line of activity. Now it sometimes happens that a leading statesman is distinguished in some other line than statesmanship. He may be a great churchman, like St. Bernard, Louis IX, Luther, Calvin, and Knox ; a poet, like Dante ; a scientist, like Bacon ; a scholar, like President Wilson, Mr. Fisher, Lord Morley, and Lord Bryce ; a philosopher, like Mr. Balfour ; an agriculturist, like Lord Townsend and George III ; a musician, like M. Paderewski. He may be eminent enough in his own sphere of work, as Bacon was, for example, to contribute ideas of profound importance for the future of mankind. Such cases, however, are rare exceptions. Most rulers are specialists in politics, and they have little time or energy to devote to other callings. Therefore almost all new ideas come from men who are not busily engaged in the work of government. The proper concern of government is not so much to create progress as to provide those conditions of peace, security, and freedom in which progress can best take place."

The authors go on to compare Government and people to a shepherd and his flock, with the Executive as the sheep-dog. "Present-day opinion," they say, "regards sheep, shepherd, and dog as having very nearly the same level of intelligence, and as engaging in an agreeable co-operation in the search for new pastures. But it is the sheep themselves who do most of the discovery, while the special task of the shepherd and his dog is to keep order, to take care of the lambs, and to help the sheep that have grown old or infirm. . . . A cynic would perhaps be inclined to add that at the present time the shepherd is actively engaged in fleecing the flock."

Let us hope that a new and golden fleece may grow before long.

Territory in Bird Life. By H. ELIOT HOWARD. (John Murray, 21*s*.)

Mr. Howard deserves our gratitude, for he has brought to light a new factor in the life of birds. His conception of "territory" and the part it plays in the avian life-cycle was already outlined in his remarkable monograph on the British Warblers. That, however, was costly and not readily accessible; and we are glad that he has devoted a separate work to a consideration of the idea and of its general bearings.

It is refreshing to find field-work leading to conclusions of such wide application. The average ornithologist had begun to think that there was nothing new to be learned from British ornithology at least—nothing but an amplification of our old knowledge. In reality, the most valuable results lie waiting for those who have the interest and the patience. The reviewer remembers with what surprise he discovered that the courtship habits of such a common species as the Redshank were scarcely known, and the wonderful pleasure that it was to dig up new facts and new general ideas from the nuptial activities of the Crested Grebe.

The man who is content to make records or to collect skins and eggs will, unless he spend years of his life in a systematic analysis of his own and others' facts, not get anything from his labours—save the very real pleasure of making the observations. But he who takes the trouble to think out new problems and new lines of attack upon the old will have the same pleasure, and in addition the joy of intellectual discovery. It is the man who is willing to build an observation post in a rookery, to make a detailed psychological study of any common bird, to observe the whole sexual cycle of a species—always with some general idea to guide him—who is likely to achieve results.

As the field studies of Bates introduced us to a new idea—of Mimicry in butterflies—so do these of Howard to a new idea—of Territory. As a result of seasons of patient watching among English fields and woods, he has arrived at the conclusion that practically all our birds, when the mating season comes round, stake out a territory for themselves, and that this territory is in most instances the pivot on which their sexual life turns. Usually it is the male who annexes the territory, spending all or most of his time in a given, limited area which he defends from other males; and this annexation occurs long before he appears to manifest any interest whatever in the females. We find that this occupation of territory takes place in essentially the same way in migratory and non-migratory forms, and in forms belonging to the most widely different groups. In the Warblers, the males come over from their winter-quarters a week or more before the females. They then occupy a definite area, fighting, if need be, for its possession, and spend almost the whole of their time in singing. When the females arrive, there is no courtship in the ordinary sense; on the contrary, the males seem to be almost oblivious of their future mates, and any fighting there may be is between females, for the possession of the occupied territory! Only after the territory is thus staked out, and occupied by a pair of birds, do the activities which are usually summed up as "courtship"—a very poor term in this case—begin, the male assuming the most extravagant attitudes and performing actions obviously directed at the female.

In non-migratory passerine birds like the unrelated Fringillidæ, the same sort of procedure is gone through. Yellow Buntings, for instance, during the winter collect in flocks on the stubbles. As spring begins, male birds will detach themselves from the flock for a short period each day, and repair to a particular stretch of hedgerow, in which they will spend most of their time on a particular tree, singing. As the season advances, they will spend less and less time with the flock, more and more in the territory, in ever greater activity of singing—until at length the flock has disappeared, since the females finally leave it too, and search for a mate and a home, as in the Warblers.

Even in quite a different order of birds the behaviour is similar. Peewits have their territories round the nest, staked out in just the same way by the males in early spring, some time before any sexual activity proper is in evidence at all.

In fact, Mr. Howard claims that territory in some form or other plays a part in the life of all birds, and substantiates his claim for the most unlikely forms—promiscuously-mating species like the Cuckoo, gregarious cliff-dwellers like the Guillemot, and even (though here, it must be confessed, with considerable limitations) polygamists like the Blackcock or Ruff. Not only does he make this claim, but I think it must be allowed that he substantiates it.

Territory is most important of all in forms, like the Warblers, where the young are hatched naked, and cannot be left long uncovered without risk of dangerous chilling. Here the size of the territory is regulated according to the food-supply and the ability of the parents to find it, and the pair spend the whole of the breeding-season within its confines. A similar state of affairs holds for Kingfishers, which divide up their rivers into sections. The Crested Grebes, on the other hand, make the open water a common fishing-ground, and only delimit territories round their nests in the fringing [illegible] of reeds. Finally, in such birds as the Guillemots and [illegible], whose nesting space is exceedingly limited, but whose feeding-ground is the unbounded sea, the territory is restricted to a few square feet upon a ledge of rock. It is none the less important for that, and the same instincts are displayed to stake out claims, the same fights occur for possession.

During the breeding-season, the whole instinctive life of the bird is conditioned by the territory first and foremost, and only in lesser degree by the presence of its actual or potential mate. Of this curious fact, which holds most rigorously in the common monogamous birds, Mr. Howard gives a number of instances. For example, he observed how the male Lapwings which had detached themselves temporarily from the flock, and were occupying territory, were quarrelsome and impatient of intruders, whether male or female, while the same birds during a part of the day when they had returned to the flock were as good-natured as the rest. But if the flock happened to be frightened up into the region of the territories, their occupiers would be just as jealous of the presence of the flock as of single birds. Further, in this stage of the yearly cycle the males took no particular interest in the females.

It is impossible to go into more detail here. The theory of Mr. Howard in most general terms may be stated as follows. Territory in some form or other is of prime biological importance in the life of birds (and probably of other groups as well). The first sign of sexual activity—the first effect, presumably, of the vernal change in the sexual organs—is in most species seen in the instinct of the males, not, as has usually been assumed, to seek out the females, but to find, occupy, and defend a territory. So far as there is choice of mates in monogamous species, it is by the females, who seek out the males; but they only compete for those males who are in possession of territory. Even when the pair is established in the area, the occasions when the female is the primary object of the male's actions is only during the so-called courtship, whose function is to stimulate the female psychically and bring her to the condition in which pairing may be accomplished; but both male and female, singly and as a pair, still react to the fact of territory, and are always active in its defence. Mr. Howard quotes an illuminating observation: he saw a weasel passing through the territory of a pair of Reed-Buntings, who were pursuing it in rage. Another male of the same species of bird approached. But instead of welcoming it as an aid in driving off the intruder, the male whose nest was actually in danger several times left the pursuit of the weasel to attack the other Reed-Bunting!

It is clear that such a concept is of great importance, both as something new in itself, and as exerting a marked influence upon our theories of sexual selection. The primary sexual instinct of birds becomes the instinct to occupy territory; the primary function of song is to advertise the possession of territory.

We congratulate Mr. Howard upon having discovered a principle of such importance, upon the intrinsic interest of the observations on which he bases his case, and upon the presentation of that case in this work. Praise is also due to the charming illustrations by Lodge and especially by Gronvold—full of life and point.

Here and there Mr. Howard has perhaps generalised a little too far. The mental life of birds is more varied than most people think, and their life-histories show most remarkable divergencies. Mr. Howard has for the most part confined himself to Passeres and to Limicolæ. In other groups, things sometimes are a little different. For instance, in the Crested Grebe, hostility between pairs does not seem to be manifested only within the boundaries of the territory of one of the pairs, but anywhere. This would mean that the mate played a more important part in conditioning the mental reactions than in Warblers or Buntings. Again, in Herons and Egrets (at least in the two American species with whose habits the reviewer is familiar), it is not the male who seeks out the territory long before pairing-up, but pairing-up occurs on the communal feeding-grounds, and the couple then, deserting the flock, *together* choose and occupy a nesting-site (often abandoning one or two sites before finally satisfying themselves). Mr. Howard also believes that one bird of a pair which is in possession of territory will never desert its mate in favour of another bird. However, the female of a pair of Black Swans which recently came under observation not only deserted its mate for an older bird, but now takes an active part in driving its former husband off whenever he appears upon the scene.

These, however, are minor points. The main thesis stands, and will remain of prime importance for our understanding of the life of birds. The general biologist no less than the naturalist and the lover of birds should read and ponder this book.

JULIAN S. HUXLEY.

The Essentials of Mental Measurement. By WM. BROWN, M.D., D.Sc., and GODFREY H. THOMSON, D.Sc., Ph.D. (Cambridge University Press, 21*s.*)

This is a new volume of the Cambridge Psychological Library. It is a revised and expanded edition of Dr Brown's book published in 1911. A large amount of new material has been added by Dr. Godfrey Thomson. For experts and students only.

Queen Victoria. By LYTTON STRACHEY. (Chatto & Windus, 15*s.*)

The Mystery of Space. By ROBERT T. BROWNE. (Kegan Paul, 15*s.*)

The Great Riddle. By FRANK HORRIDGE. (Kegan Paul, 3*s.* 6*d.*)

DISCOVERY

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Editorial Notes

The Managing Committee of Discovery regret to announce that, through the pressure of his work at Oxford, Dr. A. S. Russell will be obliged to relinquish the Editorship in the near future, though he has kindly consented to continue to act as Scientific Adviser. The Committee is well assured that it represents the feeling of many thousands of readers in offering Dr. Russell its cordial thanks for the invaluable service he has rendered to the journal in its first and most critical year; and in expressing great satisfaction that he will continue his help in securing articles on scientific subjects and advising the editor on any questions connected with them.

* * * * *

The April number of the *Psychic Research Quarterly* has interested me very much, and makes me feel the sorrier that it is shortly to be turned into a larger and more ambitious periodical called *Psyche*, which intends to review the whole field of psychological inquiry. Such a periodical no doubt will meet a growing need, but the problems and difficulties of psychical research might have been more conveniently discussed in a smaller periodical devoted exclusively to it.

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In the April number is a curious article by the Rev. C. Drayton Thomas on Book and Newspaper Tests. Tests of this kind are a comparatively recent development in Psychical Research, and are considered to be among the most interesting and important phenomena at present under investigation. In a book-test the "spirit" through the medium sends a message in which part of the message is connected with a word or a sentence on a certain page of a book. This stands in a certain part of the house, and was known to the "spirit" when he was alive but is unknown either to the medium or to the person for whom the message is intended. For example, the message which the medium receives from the "spirit" deals with a great controversy in the Press, and gives a reference to the middle of p. 54 of a certain book standing, say, third from the left end in a certain bookcase in a certain room. Later, after the séance, in the middle of p. 54 of the very work cited by the "spirit" occurs the sentence—

". . . when the hour for combat strikes and the decision . . ."

And there you are: Strikes—Strike—Coal-strike—Great Controversy in the Press!

* * * * *

In Mr. Thomas's experiments the information he received periodically through the mouth of the medium was verified (or he believed it to be verified) in *The Times* of the day after the séance. On a first reading of his article it all appeared to me to be rather wonderful, but a rereading made me much less convinced. There seems to be no reason to look for any abnormal explanation for these phenomena. Gullibility, chance, coincidence, an occasional good guess, the ability of a certain type of mind to put two and two together and make it (within limits) into almost any number, and a few similar explanations, seem to me to account for them all. Mr. Drayton Thomas very wisely always sent the notes predicting the event to a disinterested person on the day before *The Times*, which confirmed the event, came out, so that one obvious explanation of the matter is excluded.

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Here is, from his notes, one message received from the medium :

" In column one and about a quarter down is your father's name given in connection with a place he knew very well about twenty years ago " ; and here is Mr. Thomas's comment upon it :

" Between a quarter and a half-way down is the name 'John' and one inch above it is 'Birkdale.' My father's name was John, and 'Birkdale' is the name of the house he bought when retiring from active work and where he resided until his death."

This is a typical example from Mr. Thomas's article. At first it struck me as so ingenuous that I suspected the author of pulling my leg. But no. He is serious. Come, now, is there anything wonderful about the name John (not Hieronimus or Jared or Septimus Eric, but John) appearing in any column of *The Times*? It would be more wonderful, surely, if it failed to appear less than ten times. Again, there is nothing wonderful in the apparent fulfilment of the prophecy concerning Birkdale. Notice, Birkdale is not mentioned specifically by the medium. It is merely a particular example of a general category, places which a man knew twenty years ago. Now, in 1901 I was only a small boy, but the number of places I knew " very well " then was anything from a hundred to a thousand, depending upon what is meant by a place. The probability that the name of one of these should appear in a column of *The Times* is a very great one. *These* book-tests, indeed, are rubbish. There is absolutely " nothing in them." Mr. Drayton Thomas does not appear to understand coincidence and correlation.

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In the same magazine is an interesting and informed article by two authors on Spirit-photographs which deserves to be read widely. The conclusion of the authors is that most spirit-photographs appear to be fakes ; but the most interesting part of the article lies in the description of the numerous methods by which a photographer who wants to deceive may do so. Many of these depend upon co-operation between the photographer and an accomplice, some merely on sleight-of-hand, some simply on knowing your audience, and some on certain scientific facts known to the deceiver but unsuspected by his clients.

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Who would imagine that it is possible for a photograph of a suitable object to be taken in a perfectly dark room by a plate that has been carefully wrapped up and sealed and never previously exposed ? Yet anyone who has persevered in the science of physics as far as the standard required for London Intermediate knows there are rays invisible to the eye which can penetrate with ease several layers of paper and affect the plate (or film) photographically. In such a case wrapping up the plates and sealing them, as spirit-photographers love to do, is analogous in simplicity to shutting and sealing up the gate of a field on a windy day to keep out the draught !

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A camera may record a good deal more than meets the eye. Invisible stars, for example, may be detected by the photographic plate. A can of hot water may be photographed, by a long exposure, in a perfectly dark room. A well-known instance of a similar phenomenon is Sir Robert Ball's story of the writing on the side of the " Great Eastern " which was successfully photographed a great many years after it had been painted out and rendered invisible. The reader may also be referred to the article on radiography in the present number. The man who wants to believe in spirit-photographs is inclined to believe, or is led to believe, that anything *he* cannot explain must be due in some way to " spirits." Naturally he cannot be expected to be a walking encyclopædia of the sciences, and so he falls an easy victim to deception.

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No amount of argument along these lines avails with some people. Many people are happier in being cranks than in looking facts in the face. Others feel that the denial of " spiritualistic " manifestations is to abandon everything, and to leave only a purely materialistic and sordid world of muscle and sex, of muck and misery. But the higher things in life—religion, idealism, the belief in a spiritual order of things—have absolutely nothing to do with table-rapping, spirit-photography, and so forth. These manifestations can be explained by natural causes, known or unknown, and by the " human touch " (which in many cases is imposture).

* * * * *

The views of Mr. Vincent Patrick (one of the joint-authors of the article referred to) on the so-called " Fairy Photographs " recently published by Sir Arthur Conan Doyle and Mr. E. L. Gardner are very interesting. He considers all this talk about the physical existence of fairies to be bunkum, and the photographs to be fakes. It will be remembered that Sir Arthur Conan Doyle said of the latter that such " rare results must be obtained when and how they can." A cynic might well remark of this that its speaker is not merely looking for trouble, but actually inviting it to assault him. Mr. Patrick, however, very wisely ignores the motives of those who are trying to popularise a belief in fairies, and relies for his evidence of fraud on the published photographs themselves. They look very genuine and the fake is very cleverly done. But fakes they are. In one entitled "Iris and the Dancing Gnome," he finds from the shadows that the strongest light is falling on Iris from the *right*, while the gnome is lighted mainly from the *left*. This is not possible. There is clear evidence also that the photograph is too artistically beautiful to be the *snapshot* it professes to be. The gnome's proportions are not human. Probably he has been sketched on to a positive enlargement from the negative of Iris, and the whole then rephotographed on to a quarter-plate.

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In other photographs, "Alice and the Fairies" and "Alice and the Leaping Fairy," the fairies appear to be human in proportions. They show a sharpness of outline which the human figure in the photograph lacks, also they are illuminated from behind while the human figure is illuminated from the side. Probably children suitably dressed have been photographed. The background has been cut out (hence the sharpness of outline), and the photos of the children have been pasted on to an enlargement of that of the human figure, and the whole rephotographed. Thus it seems to be.

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There are several interesting articles in a little book entitled *The Fight Against Disease* (Macmillan, 6*d*.) issued by the Research Defence Society. One refers to the advances recently made towards the discovery of a *protective* treatment against tuberculosis, such as at present exists against typhoid. Dr. Calmette has been working on the Protection of Cattle from Tuberculosis at the Pasteur Institute. His work is founded, of course, on Pasteur's discovery of the attenuation of virus; the gradual bringing-down, point by point, of the virulence of the germs of a disease, by growing them, in pure culture, in test-tubes, under certain conditions which have a lowering effect on them: growing them, through a long series of such cultures, in successive test-tubes, from generation to generation, and then using them, thus weakened, to protect animals against the disease at its natural strength. By this discovery, Pasteur was enabled, in 1881, to protect animals against anthrax.

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Calmette has discovered how to attenuate the germs of bovine tuberculosis, by growing them in pure culture, through many generations, on a special medium of glycerine and bile. By this discovery, he has been enabled to protect animals against the disease at its natural strength. One of his experiments may be described here. He took ten heifers, proved free of tuberculosis. He kept four of them as "controls," without any treatment; he treated six with a protective dose of germs attenuated through seventy generations of pure culture. All ten heifers were then stalled in the company of cattle which were tuberculous. This experiment was kept up for more than three years. Then the heifers were tested with tuberculin. The six protected animals came out free of the disease: but three of the four controls had acquired it.

His work is bound to move slowly, but those who know his value, and his high place in the scientific world, have reason to think well of this new research.

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The article concludes: "Some day, we shall have in our hands the inestimable gift of a protective treatment for our own children against the germs of human tuberculosis. Take, for example, the case of a family in which there is a strong tendency to consumption. Imagine it possible, by a protective treatment, to be able to help the children to tide over the susceptible years; imagine them enabled to put up more of a fight against adverse conditions. It seems already put in our hands."

* * * * *

Is there a professor of Dactylography anywhere? A bi-monthly magazine with this subject for its title is to appear on the 1st of July. It will deal chiefly with the evidence for criminal and other identifications by means of finger-prints; but attention will be given also to a study of the detective aspects of foot-prints—including boot-prints—tattoo marks, deformities, and the like. Consideration will also be given to such evidence as is usually called for from police experts regarding the minute texture of paper and other fabrics; the microscopical, chemical, and biological qualities of blood smears; poisons; evidence from wounds; attitudes and condition of the dead; the nature of the weapons used, and so on. It is intended to make this journal quite intelligible and useful to all who have to do with the detection and judicial investigation of crime.

Man and His Past,[1] by Mr. O. G. S. Crawford, a noted archæologist and geographer, is a book I have enjoyed reading. It has a freshness about it, a breadth and an optimism which one views with pleasure in a book dealing with anthropology and archæology. The main theme of the book is the need for the study of man's past, because of the demonstrably great but often overlooked importance of the past upon our present. It is cordially recommended to readers, especially to those interested in history.

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[1] Oxford University Press, 10*s*. 6*d*.

Robin Hood: the Man and the Myth

By F. L. Guilford, M.A.

[illegible] the twilight, is Robin Hood awake ?
Grey and ghostly shadows are gliding through the brake ;
Shadows of the dappled deer, dreaming of the morn,
Dreaming of a shadowy man that winds a shadowy horn.

Robin Hood is here again : all his merry thieves
Hear a ghostly bugle-note shivering through the leaves,
Calling as he used to call, faint and far away,
In Sherwood, in Sherwood, about the break of day.

In his fine poem from which these opening lines are quoted Alfred Noyes has seized on the spirit of Sherwood Forest—the Sherwood Forest of Robin Hood—as no other poet has done since the ballad-writers set down their songs on paper. To every healthy-minded boy Sherwood Forest and Robin Hood are one, inseparable and for ever associated in one of the finest tales of adventure that we have.

We have nearly all a joyful recollection of the pleasure we derived from reading the adventures of Robin Hood, Little John, Friar Tuck, Will Scarlet and the rest, and even to this day, when the critical spirit of maturity has ousted the omnivorous receptiveness of boyhood, I love to read again the pranks played by this band of joyful sinners on the representatives of authority. Many a time, when wandering in the glades of the Forest I have fancied that the spirit of Robin Hood still haunts the shadows and that the old trees, stately in their glorious antiquity, nod their sage heads as they tell once more of the deeds they saw when they were young. The exploits of Robin Hood cannot be read by anyone without some stirring of the pulse, for surely no popular hero has ever possessed so much *joie de vivre* ; he was certainly a cheerful sinner, and most people have in their hearts a soft place for all such.

The modern historical spirit is a critical one. It refuses to accept as a fact anything which cannot be proved by documentary or other irrefutable evidence. All the heroes of our childhood's history must pass through the test, and few, alas, escape unscathed. The passing of these cherished stories into the limbo of legendary history may be a gain to the pure historian, but it is a loss to the spirit of the nation, for in them is embodied much that true history never records, but which is none the less true in spirit if not in fact. No one has suffered more than Robin Hood in this respect. We are told that King Alfred never proved himself a hopeless failure as a baker, that Canute did not challenge the waves to wet his royal feet, and that Hengist and Horsa are symbols and no more ; but Robin Hood is being taken from us and placed in the realm of fiction.

It is my object in these lines to try to show how much about Robin Hood we really can discover,and if we must regretfully admit that he was a medieval counterpart of Mrs. Gamp's Mrs. Harris and that there was no such person, let us at least try to save some fragments from the rubbish-heap of history.

Robin Hood was probably the most popular hero of the medieval ballad-maker, and Mr. F. J. Child, in his monumental collection of English and Scottish ballads, has preserved nearly fifty distinct songs about him. These are really our only source of information, and if we would find anything out about him, we must seek for it within these ballads.

The earliest recorded mention of the existence of these ballads occurs about 1377 in *Piers Plowman*, where the poet refers to " Rhymes of Robyn Hood and Randolf erle of Chestre," and the earliest ballad that has come down to us appears to have been set down during the first quarter of the fourteenth century. Until recent times no one doubted that Robin Hood was a real person, and it was only when a search was made for facts about his career that it was discovered that no authentic mention of him occurs anywhere. He is merely a ballad hero and no more. Persevering seekers have unearthed at least a dozen Robert Hoods from the dusty files of official documents and have tried to fit them into the vacant niche, but none of them are acceptable, for they do not seem to be the kind of men who could even in their youth have lived the life of a chivalrous and cheerful sinner. These men have each their champions who have tried to place them definitely in the reign of Richard I, Henry III, or Edward II. But the evidence is unconvincing, and it is better that these bearers of a famous name should return to their obscurity than that we should seek to spoil the romance of Robin's life by bringing him to end it as a servant of the King, living on a pension because he was too decrepit to do his work.

On the other hand, as opposed to the school who seek to fix a date for his death we have those who try to convince us that in the story of Robin Hood we have a sun myth ; but personally we are inclined to seek for an approximation to the truth somewhere in between, and perhaps the best way to approach the subject is to see what the name Hood will teach us.

In the first place it is a common name and is found in use long before the Norman Conquest; and, what is more, it is employed in a suggestive way twice in two very different parts of the country. In an Anglo-Saxon charter relating to Worcestershire we have Hod's Oak, and in Nottinghamshire, within the bounds of Sherwood Forest, there is the village of Hodsock, which means the same and was in existence at the time when the

Domesday Book was compiled. Now, of course, the letter "h" is, and always has been, a very elusive letter, and it is quite possible that Robin Hood and Robin o' th' Wood are synonymous. That such a change is possible is shown by the certified fact of such an actual alteration taking place. In the early eighteenth century a gipsy family named Wood went to live in Wales, and to-day their descendants are called Hood. Once we discover that "Hood" and "Wood" are not entirely strangers to one another we remember that there was once a heathen god called Woden, but really the somewhat ponderous behaviour of Woden does not seem to tally with the pranks played by Robin Hood, and I would rather see in Robin o' th' Wood, Robin Goodfellow, better known as Puck; but this is pure imagination, and has no firmer base than is here indicated.

Though the ballads firmly attach Robin Hood to Sherwood Forest, yet there is evidence that perhaps his original home must be sought farther north. In Cumberland we find three ballad heroes, Adam Bel, Clym of the Cloughe, and Wyllyam of Cloudesle, whose exploits, though far fewer in number, are the exact counterparts of those of Robin Hood, with the substitution of Carlisle for Nottingham and Inglewood for Sherwood.[1] One of the ballads makes three men contemporaries of Robin Hood's father, who, if we may credit the ballad, was an even greater archer than his son:

The father of Robin a forrester was,
And he shot in a lusty strong bow,
Two north country miles and an inch at a shot,
As the Pinder of Wakefield does know.

For he brought Adam Bell, and Clim of the Clough,
And William of Clowdesle,
To shoot with our forrester for forty mark,
And the forrester beat them all three.

His mother was neece to the Coventry knight,
Which Warwickshire men call Sir Guy;
For he slew the blue bore that hangs at the gate,
Or mine host of the bull tells a lie.

In the earliest ballads that have come down to us we find that Robin has, like William of Cloudesle, two companions, Little John and Mutch, the miller's son. These are the only ones mentioned by name, though there were a considerable number of others in the band.

Robyn take a full grete horne,
And loude he gan blowe;
Seven score of wyght yonge men
Came redy on a rowe.

It is only in quite late ballads that any attempt was made to identify Robin with an Earl of Huntingdon; in all the early ones he is simply a yeoman:

Roben Hood was the yeomans name,
That was boyt corteys and fre;
For the loffe of owr ladey,
All wemen werschep he.

Robin Hood's first meeting with Little John is the subject of one of the later ballads:

When Robin Hood was about twenty years old,
He happen'd to meet Little John,
A jolly brisk blade, right fit for the trade,
For he was a lusty young man.

Tho' he was called Little, his limbs they were large,
And his stature was seven foot high,
Where-ever he came, they quak'd at his name,
For soon he would make them to fly.

Another of the band who plays but a small part is mentioned as being with Robin at this time—Will Stutely, but how he came to join the party is not related.

But I can hear my reader asking why no reference has yet been made to Friar Tuck and Maid Marian. The reason is that neither of these well-known and picturesque characters plays an important part, indeed it is only in the later songs that they appear. Scholars tell us that Maid Marian is imported into the Robin Hood cycle from France, and certainly no mention of her occurs before 1500. Friar Tuck, or the curtal friar of Fountains Abbey, is the subject of a late ballad where, like Little John and others, he gets the better of Robin Hood and is accordingly made a member of the band.

And coming unto Fountaine Dale,
No farther would he ride;
There he was aware of the curtal fryer
Walking by the water side.

The fryer had on a harnesse good,
On his head a cap of steel,
Broad sword and buckler by his side,
And they became him weele.

Friar Tuck is a curious ecclesiastic: a friar who is a member of a Cistercian community and occupying a distant cell of the mother house, and yet going about armed to the teeth. He is certainly very untrue to life, and seems to be a late creation of an inaccurate age.

In the ballad of Robin Hood and Maid Marian we find that, according to the true tradition of balladmongers, Robin is the Earl of Huntingdon and Marian is a "country lass." They fall in love, then part and, like Shakespeare's Rosalind, Marian disguises herself:

Perplexed and vexed, and troubled in mind,
She drest herself like a page,
And ranged the wood, to find Robin Hood
The bravest of men in that age.

For some unstated reason Robin is also disguised. They meet but do not recognise each other, and as always happens when Robin meets a stranger they fight and wound each other. Of course all ends happily.

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[1] Also William of Cloudesle performs the apple-shooting feat of William Tell.

> In quiet content together they liv'd,
>   With all their yeomen gay ;
> They liv'd by their hands, without any lands,
>   And so they did many a day

Now there is a point about all the Robin Hood cycle of ballads which strikes us and leads us to a fresh aspect of the whole matter. Whenever the time of the year is mentioned it is always summer, and generally early too. The earliest ballad of all opens with :

> In somer when the shawes be sheyne
>   And leves be large and longe,
> Hit is full mery in feyre foreste
>   To hear the foulys song.

If we study the characters who took part in the May games, we find that Robin Hood and Maid Marian appear and are representatives of the Hobby Horse and May Queen respectively. Probably the popularity of these two brought them in, but we find in parts of England a curious Christmas custom known as the "Hoodening Horse." A roughly-carved horse's head was carried round and a collection of money made. What is the meaning behind these facts? Is there any connection between the part played by Robin Hood and the Hoodening Horse, and can we see in the latter a survival of a very old reverence for the horse as typifying the spirit of the corn, which had to be pacified in order that the year's crops might be good? We are getting out of the realms of history—if we have ever been in them—beyond romance, and are trespassing in the treacherous morasses of folk-lore. But the more we seek to find the origin of Robin Hood, the more are we attracted down seductive bypaths, and as we return more puzzled than before, we realise that though we are no nearer a satisfactory solution, yet we feel we are studying a subject which may at any moment reveal to us a vast unconquered world.

Probably the ballad-monger thought it only fitting that his hero should die, and so a story was invented of his visit to his cousin at "Kirkley-hall" and her treachery in bleeding him. When he realises that he is dying, Robin blows his horn and calls Little John to his side, and his directions to him are well worth quoting :

> But give me my bent bow in my hand,
>   And a broad arrow I'll let flee ;
> And where this arrow is taken up,
>   There shall my grave digg'd be.
>
> Lay me a green sod under my head,
>   And another at my feet ;
> And lay my bent bow by my side,
>   Which was my music sweet,
> And make my grave of gravel and green,
>   Which is most right and meet.
>
> Let me have length and breadth enough,
>   With under my head a green sod ;
> That they may say, when I am dead
>   Here lies bold Robin Hood.

So it was that in the seventeenth century it was thought fitting that a tomb at Kirklees Nunnery should be ascribed to our hero and that his epitaph should be placed on record. A later writer, early in the eighteenth century, supplies us with a fresh inscription and the actual date of his death—November 18, 1247.

What, then, can we gather from all this medley of fact and fiction about Robin Hood? If he had an actual living prototype, we must go back very far, so far that no historical record remains. Once he had become the hero of the ballad-singer Robin made rapid advances, and yet most of the additions which we can definitely state to be of later origin are of a stereotyped form. Robin's deeds are not peculiar to him, and the characters who gather round him are part of the stock in trade of the professional ballad-singer. If we could get the ballads in their earliest form we might learn more, but that, unfortunately, is impossible and we must leave Robin with the fitting words of his own chronicler :

> Thes partyd Robyn, the screffe, and the potter,
>   Ondernethe the grenewood tre ;
> God haffe mersey on Robyn Hodys solle,
>   And saffe all god yemanrey !

The Radiography of Pictures[1]

How the Forger of Spurious "Masterpieces" can be defeated by the X Rays

By George Frederic Lees

"Do our readers know that there exists in Paris a manufactory in which artists, receiving large salaries, copy the canvases of the Great Masters? These pictures are sent to the United States, a high duty is paid upon them, and, being thus stamped as authentic, they are then sold for their weight in gold to American millionaires. In the gallery of one of these collectors can be seen quite a number of pictures the originals of which are either in Paris or in the provinces."

Writing, many years ago, in the *North American Review* on the subject of the traffic in spurious pictures, I had occasion to quote the above paragraph from a

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[1] Illustrated with Photographs and Radiographs by Dr. André Chéron, of Paris.

Paris morning newspaper. The production of forged "masterpieces" bearing the names of Van Ostade, Ruysdael, Hobbema, Raphael, Boucher, Watteau, Corot, Diaz, Théodore Rousseau, Ziem, and other eminent painters of ancient and modern times was then most intense. Not merely one manufactory, as the paragraphist seemed to think, but quite a number of studios where picture forgers worked existed in the Montmartre and Montparnasse quarters, without counting those which were in the suburbs and provinces. Whereas in previous years these copyists, *pasticheurs*, and painter-restorers—each working at his own speciality—could be counted on the fingers of both hands, they had become a veritable army in the days to which I refer, and, though armed but with brushes and colours, the havoc and confusion they wrought was great indeed. Connoisseurs all over the world have still to be on their guard against the clever productions of these picture "fakers"; and so numerous are spurious canvases signed with great names, due not only to these unscrupulous forgers but to their predecessors and successors, that there is probably not a single public or private picture gallery which does not contain their handiwork.

Arrested during the period of the Great War, the lucrative trade in spurious pictures has been resumed and is now once more in full swing. Painters, painter-restorers, and others with a talent for this particular branch of fraud are hard at work in secret, employing the same old methods that were in vogue during the nineteenth century, but applying them to the production of works bearing the names of artists, both ancient and modern, who have come into their own of recent years. The contest between the picture forger and his prospective victim, the connoisseur, being eternal, it will be well, before describing a means by which many forgeries can be unerringly detected, to understand the various tricks resorted to by the fraternity of picture "fakers."

It is useful to know, for instance, that when, some thirty to forty years ago, pictures by Masters of the 1830 school came into favour, all the canvases by pupils of Corot, Diaz, Troyon, Rousseau and others were collected and re-signed. That is the reason, an expert assures me, why there are so few pictures by Villers and Mazon to be found. These excellent painters produced many works, but because of the greater renown of Millet and Corot, it was their fate to be absorbed, as it were; their paintings are hanging at this very moment in the galleries of great collectors, but baptised with other names than those of the men who painted them! One wonders if their signatures were entirely removed or merely covered up, in which case it is now possible, as will later be shown, to bring them to view.

About the year 1880, genuine pictures by Corot, Daubigny, Diaz, and Théodore Rousseau used to be copied by the clever hirelings of certain Parisian art-dealers. In one instance, the copyist, working at a house in the country, alone with a single servant, made twenty-five copies of each picture, slightly varying the subject in each case. He produced one hundred copies in ten months, and all of these, as leaked out later through indiscretions, were sold in the United States as originals from the collections of this or that well-known Parisian. To detect the hand of the forger in such a case as this, presuming that he is really an expert worker, is extremely difficult, if not impossible; one must look for evidence of the fraud in other quarters.

Infinite precautions are now taken by reputable art-dealers who represent great modern painters to protect the artists' interests, those of the heirs, and their own pockets against possible fraud. Every work produced is carefully photographed and catalogued. On the death of a celebrated artist, a photographic reproduction is made of every work, study, or sketch in his studio, so that when these are dispersed they will be in possession of a weapon against the picture forger who may be tempted to acquire an unfinished landscape and complete it after the manner of the Master. It is when the copyist, aided by the painter-restorer, comes to work on old canvases that he is liable to be unmasked. The *modus operandi* in this particular branch of "faking" is as follows:

A dealer collects together a number of pictures by one or other of the Old Masters whose works are not in vogue—if possible pictures by a painter who worked somewhat in the style of this or that celebrated artist; and from these, by means of skilful retouching, works are produced which eventually bear the magic names of Rembrandt, Raphael, Teniers, Corregio, and others. In the case of portraits and pictures containing figures, such as those by Largillière, a similar method is adopted, only care is taken to select canvases the light parts of which are uninjured and as near as possible in the style of the Master whose work is to be imitated. With the assistance of good engravings, the drawing is slightly altered; half-tones and shadows are added; and, by means of glazes, the necessary piquancy and effect are produced. Naturally, canvases of the correct period, and genuine old stretchers—or panels, in the case of painters who usually painted on wood—are selected. Such works by Old Masters who are not in vogue and are never likely to be, except as material out of which "masterpieces" are made—such old stretchers and panels are often on sale at the Hôtel Drouot, the great sale-rooms in the street of that name in Paris. Many people unacquainted with the work of the picture forger wonder how it is such "rubbish" finds eager purchasers.

The patina and cracks of old pictures are what give the most trouble to those who use this ancient trick. Some picture forgers use saffron, bister, liquorice, or black coffee, which have now replaced bacon rind, so much used in former years. When this has been applied and is quite dry, the picture is varnished. Sometimes thick oil is added to the varnish, or it is coloured with bitumen, yellow lac and red ochre, which give almost exactly the tone of old varnish.

Up to recent years the only way of frustrating the dishonest picture-dealer and his accomplice, the copyist or painter-restorer, was to have recourse to expert opinion. Long study of the undoubtedly authentic works of the Great Masters enabled such experts and art-critics as Paillet, Regnault, Delalande, Duclos, Thore Burger, Philippe Burty, and Eugène Piot to pronounce accurate judgment, at any rate in a large majority of cases, whenever the authorship of pictures was in dispute. Thus picture buyers were put on their guard, especially when the science of the art-critic was supported by those who made it their business to record the multitudinous instances in which spurious pictures were declared to be forgeries. Connoisseurs were able, thanks to special advice and annotated catalogues, to avoid falling into the traps which were perpetually being laid for them by unscrupulous dealers. They were aware, for instance, that in 1868, on the occasion of the sale of the collection of His Excellency Khalif-Bey, two Fromentins were declared at the sale to be mere copies; that in the following year, at the Besborodko Sale, several pictures, including one Albert Cuyp and a Rembrandt, were likewise denounced; that at the Schneider Sale, in 1876, two Rembrandts were sold as doubtful; that in 1899 a Nattier, belonging to the collection of Mme Richard, née Bournet Aubertot, was sold for 49,500 francs, despite the fact that many well-known judges present at the sale declared it to be a forgery; that at the Guasco Sale, in 1900, a Troyon was falsely described as having been in the collection of the painter and bore a forged stamp of the Troyon Sale; and that at the Rey Sale, in the same year, a so-called Raphael was sold as a genuine work, the description in the catalogue being inaccurate as far as that particular work was concerned—it applied to quite another (genuine) work. But this system of keeping track of the innumerable forgeries which are in circulation, satisfactory though it was in a great number of cases, naturally broke down at times. Forgers of exceptional skill have succeeded in deceiving the most erudite critics, hence the conflict of opinion which has often arisen, as in the dispute in London some years ago over an alleged Romney, in art circles. Manifestly a more infallible method of examining the *facture* of a given painting was required; and to find it a number of scientists set their wits to work, with most interesting results.

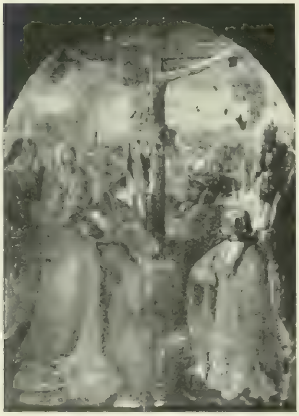

Fig. 2.
RADIOGRAPH OF THE "CRUCIFIXION" BY ENGELBRECHTSZ.

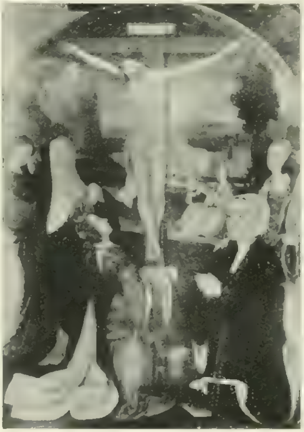

Fig. 1.
THE "CRUCIFIXION" BY ENGELBRECHTSZ. THE PICTURE BEFORE RESTORATION.

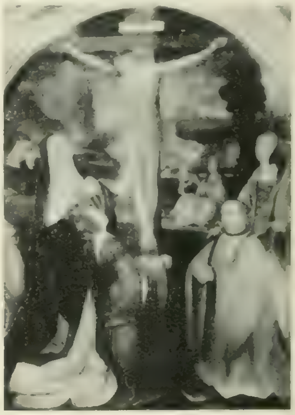

Fig. 3.
THE "CRUCIFIXION" BY ENGELBRECHTSZ, IN ITS PRESENT STATE AFTER RESTORATION.

Professor A. P. Laurie, of Edinburgh, called in the aid of the microscope to distinguish the characteristic brush-work of the Great Masters, and thereby discovered that the methods of applying the paint had changed but little since the days of antiquity. Artists living at the time of the Roman Emperors painted with large and small brushes on canvas, which they prepared with a basis of oil, gum, and glue, afterwards varnished.

The drying of their pictures, however, presented difficulties, owing to ignorance of the difference between pure oil and siccative linseed oil; and to remedy this the galipot method was then adopted—that is to say, colours were first of all ground with turpentine and then, when in the form of powder, diluted with a varnish composed of the said galipot (white resin, a sort of turpentine) and spirits of turpentine. This technique changed but little down the Ages, bringing Professor Laurie to the conclusion that as regards the instruments of their art there was practically no change from the days of Leonardo da Vinci to those of Renoir and the Impressionists. However, the pigments used in painting *did* vary considerably from period to period, and by applying his method to a large number of works of absolutely certain date, the investigator with the microscope was able to draw up a chronological list of pigments of the greatest utility. Microscopic study of the pigments of a given painting enabled one, then, in many cases, to determine its date approximately and to declare whether any portions had been retouched by restorers. Advancing this excellent method one more step further, Professor Laurie took micro-photographs of minute portions of ancient canvases, enlarged from one to six diameters; whereupon it became evident that, in the fight against the picture-forger, photography and its various applications was to play one of the most important of rôles.

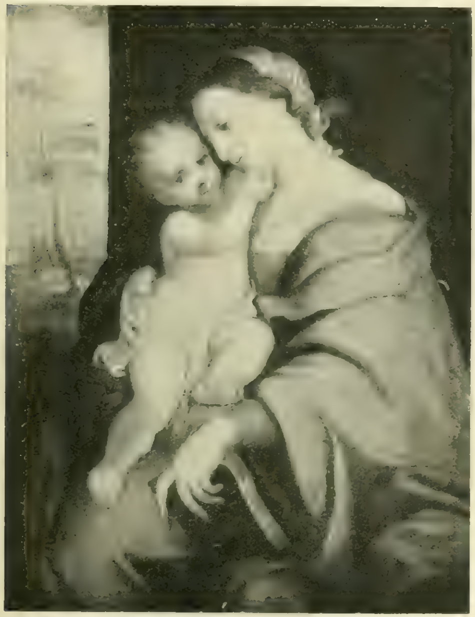

FIG. 4.
"VIERGE DE STELLA."

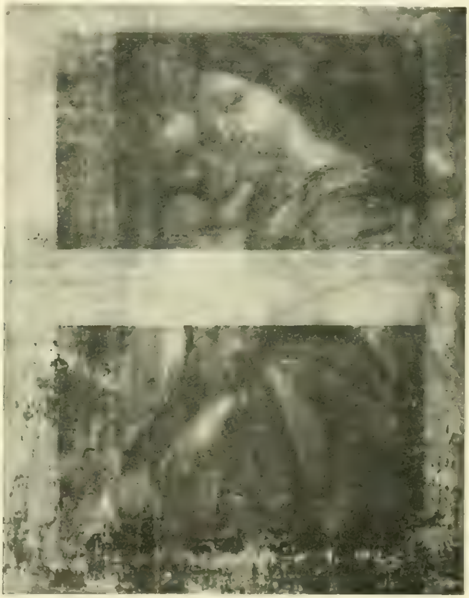

FIG. 5.
RADIOGRAPH OF THE "VIERGE DE STELLA" SHOWING DAMAGED PORTION WHICH HAS BEEN RESTORED.
In the centre a bar of wood prevented complete passage of the X rays.

To H. Parenty, of Lille, is due the credit for having discovered that by simple photography it was possible to penetrate the undeniable transparency of the layers of paint on pictures, and thus reconstitute, as it were, certain details in the works of Titian, Rembrandt, Rubens, and other Great Masters that are invisible to the naked eye. This at once led other technologists to ask themselves the question, Why not employ X rays? No sooner said than done. And thus, in 1914, the first researches concerning the radiography of pictures were made in Germany by Faber, as related in the *Zeitschrift für Museumkunde.* Dr. Heilbron, of Amsterdam, continued them with most curious results. Finally, between the middle of 1920 and the present date, we find a Parisian specialist, Dr. André Chéron, perfecting the method to such a degree that we are tempted to say the days of the picture forger are numbered.

Dr. Heilbron's results must first of all be described. As the subject for his investigations he took a "Crucifixion," by Engelbrechtsz, a picture which was suspected of having been tampered with. It was noticed that the figure of a nun in the foreground on the right was not in harmony with the other personages (Fig. 1), and as the canvas had been presented to a certain religious establishment by a nun, it was thought to be more than likely that this kneeling praying lady with white cap and rosary was a portrait of the donor, added by a painter who came long after Engelbrechtsz. Dr. Heilbron radiographed the "Crucifixion," with the result predicted: beneath the clumsy addition was the original figure, that of a praying monk, in perfect harmony with the rest of the picture (Fig. 2). Apart from this revelation, radiography served the useful purpose of showing the artist's own brush-work before restoration and enabled this work, which unfortunately, as is the case with all very ancient pictures, had become indispensable, to be more skilfully restored to its present state, as shown by Fig. 3.

FIG. [illegible]

ROYAL CHILD AT PRAYER

Fifteenth century picture in the Louvre

Working in accordance with the indications given by Faber and Heilbron, and guided by his own great experience as a radiographer, Dr. André Chéron—to whom, let me say in passing, I am indebted for the illustrations accompanying these lines—has considerably advanced the science of the radiography of pictures. Here, in a few words, is the principle of his method; I quote from his communication presented to the Academy of Sciences, at Paris, by Dr. Lippmann, at the sitting of January 3, 1921:

"We know that the degree of transparency of bodies to X rays depends on the number and weight of the atoms of which they are formed. Now, in the case of a picture, there are three things to be considered: the support (canvas or panel of wood), the priming with which this support is covered, and finally the colours composing the picture.

"The support is always very transparent, but canvas much more than wood.

"As regards the priming, it appears to result from the documents we possess on the subject of the making of colours and the preparing of canvases and panels that the old painters primed their supports with a mixture of carbonate of lime and glue, which is relatively transparent to X rays. At the present day, on the contrary, painters use, almost exclusively, a priming of white lead, which is much more opaque.

"As to the colours used by the artist to compose his subject, they are also of atomic weight, and consequently of a most variable transparence to the rays. Some, such as white, are and have always been almost exclusively composed of heavy salts, of lead or of zinc; therefore they are a serious obstacle to the passage of the rays. Others, such as bitumen and most of the blacks, are extremely light and allow the rays to pass through very easily. Finally, between these two extremes, we find a whole series of intermediaries.

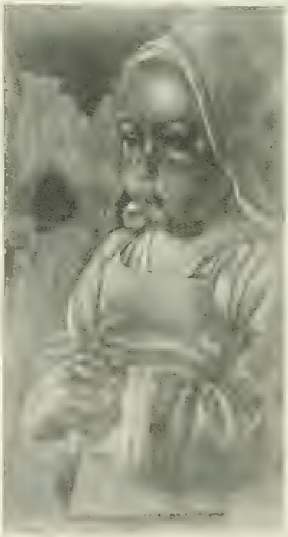

FIG. [illegible]

RADIOGRAPH OF "ROYAL CHILD AT PRAYER."

Showing damaged background.

"But a certain number of colours which were formerly made from mineral salts are now sometimes formed from vegetable substances much more transparent, e.g. madder. The same applies to certain modern colours with an aniline base.

"Now, it is very evident that, in order to obtain a good radiographic image of a picture, two things are essential :

"1. The transparency of the support and the priming.

"2. The relative opacity of the colours or at least of certain of the colours employed in the contrasts forming the image.

"Precisely these conditions are found united in ancient pictures. On the other hand, modern pictures provided with a somewhat opaque priming covered with colours often more transparent to the rays give much less perfect images, which are often even almost invisible."

Dr. Chéron, whilst hesitating to draw hasty conclusions from his researches, went on to say that one might, therefore, sometimes hope to discover through radiography the age of a picture and consequently reveal its authenticity. Another result, thanks to X rays, was the power to show all the damage a work of art has undergone down the ages, notwithstanding the most skilful restoration. In fact, as ancient pictures are in question, the priming and colours used for restoration would be of a different manufacture and probably of a different atomic weight, and would be reproduced on the plate by veritable spots with a perfectly definite shape, revealing ravages sometimes unsuspected.

"Finally—and this is perhaps the most interesting side of these researches," continues the Doctor, "picture radiography reserved very many surprises. To see a picture by transparence is to know its history in part. Apart from the fact that the artist himself may have modified his work whilst painting it, the portions 'faked' or repainted, the additions made to it are revealed to us ; without mentioning the various unexpected discoveries of entire pictures under works of later date."

I have reason to believe that when Dr. Chéron wrote these last words he had in mind the statement that, at the time when David and the painters of the Classical School were at the height of their popularity, some of the canvases of Fragonard were regarded as of such little artistic value that the artists of that School used them for the production of their own works. What a prospect, indeed, the radiography of pictures opens up for us in that direction !

We will now turn our attention to the pictorial demonstration of Dr. Chéron's researches—a most convincing demonstration if ever there was one.

Figs. 4 and 5 display very clearly the contrast between the radiograph of an ancient picture and the picture itself. The "Vierge de Stella" has clearly-defined outlines and the figures can be recognised. On the other hand, it reveals, at the bottom of the picture, restoration the extent of which was unsuspected. In a modern picture, on the contrary, no image would be visible, apart from those parts which alone are formed of a colour sufficiently opaque to make a shadow through the white lead priming covering the canvas.

Figs. 6 and 7 are of special interest, since this picture of a "Royal Child at Prayer," belonging to the French School of the fifteenth century, is in the Musée du Louvre, where it was only recently radiographed. The Curators of the gallery believed, in accordance with statements made in certain documents, that the original background of the picture was at some time or other greatly damaged, and that about a century ago the damages were masked by means of the uniform black background now seen in the picture. This hypothesis is wholly confirmed by the radiograph. Moreover, it shows that the painter at first made the child's bow a little too large and then corrected his error.

Many photographs show how easy it is to unmask the picture forger by means of radiography. One of the pictures radiographed represented a little Flemish scene with country folk dancing and playing musical instruments. The radiograph was most curious, for there was not a trace of figures (apart from the head of one of them, faintly visible in the centre), but in their place appeared two peacocks, two ducks, and two hens with very clear outlines. Evidently the picture was really two pictures, one over the other on the same support, in this case a wood panel. The first picture, that of the birds, was an ancient work, since there was no opaque priming to destroy the clearness of the outlines ; the second—falsely attributed to Van Ostade—was probably modern, since the colours, with the exception of the whites, were almost uniformly transparent to the rays.

It should be said, in conclusion, that these results have produced a profound impression in Parisian art circles. M. Jean Guiffrey, the Curator of the Louvre, finds them "most interesting." The well-known critic M. Charles Henry says : "There can be no doubt that this method of examination is capable of furnishing experts with new and precious elements" to enable them to form an opinion. Whilst that excellent publication *Le Bulletin de la Vie Artistique* pronounces the scientific value of Dr. Chéron's work as undeniable. Henceforth it ought to be impossible for any more spurious "masterpieces" either to come into sale-rooms or pass the Customs at the port of New York.

Bibliotheca Chemico-Mathematica. A catalogue of works in many tongues on exact and applied science. Two vols. (Henry Sotheran & Co., 63*s.*)

To be reviewed next month.

Rock Dwellings in Cappadocia

By W. R. Halliday, B.A., B.Litt.

Professor of Ancient History in the University of Liverpool

THE soft volcanic tufa of many parts of the Eastern Mediterranean has given a long life to the primitive practice of cave-dwelling. In the Cyclades, notably in Santorini (Thera), the houses are often little more than façades built on to hollows in the rocks, and the back rooms are in fact caves. For this casual practice of cave-dwelling convenience may no doubt account and the desire to expend as little trouble as necessity demands. Further East, however, in Asia Minor, a less fortuitous troglodytic existence has been deliberately adopted and whole settlements have been excavated underground. Here the motive seems more probably to have been the desire for security in a troubled land.

When Xenophon and the Ten Thousand were fighting their adventurous way to the sea after the Battle of Cunaxa had stranded them masterless and friendless in the heart of hostile Asia, they encountered upon the borders of Armenia a people who lived in underground burrows. "The houses were underground structures with an aperture like the mouth of a well by which to enter, but they were broad and spacious below. The entrance for the beasts of burden was dug out, but the human occupants descended by a ladder. In these dwellings were to be found goats and sheep and cattle and cocks and hens with their various progeny. The flocks and herds were all reared under cover upon green food. There were stores within of wheat and barley and vegetables, and wine made from barley in great bowls." Of this beer Xenophon adds that it is very potent and "of a delicious flavour to certain palates, but the taste must be acquired."[1]

A good deal to the west of Xenophon's line of march, in the Cappadocian Plain between the southern bend of the River Halys and the Taurus Mountains, very similar burrows can be visited to-day. The present villages above ground are composed of miserable houses built of sun-dried brick and plastered with dung. In summer the latter commodity, which is also dried to serve as fuel cakes in a country of cold winters but destitute of trees, somewhat obtrusively pervades the air. In winter the snow lies deep on this plateau five thousand feet above the sea. In severe weather the animals are all taken indoors as Xenophon saw them in December 401 B.C. Over a brazier a large felt rug is spread, and round it the members of the patriarchal household recline with their lower extremities beneath the rug. Thus through the worst of the winter man and beast hibernate together in an atmosphere which, if warm, must possess other less pleasant qualities.

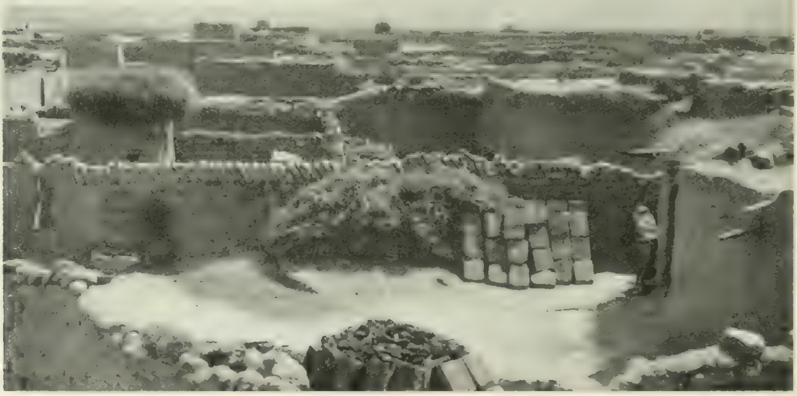

FIG. 1. VILLAGE OF AXO, SHOWING SUN DRIED BRICKS AND FUEL CAKES.

Beneath these villages, which are inhabited for the most part by a Christian Greek-speaking population, there lies a rabbit warren of subterranean dwellings, and in them the inhabitants may formerly have lived. Local tradition at Mistí, a large village of 800 households, which lies on the high road from Nigde to Kaisarieh, assigns a recent date to the emergence of its population from these burrows, and it is improbable that the houses have existed above ground much longer than the church, which was built in 1844.

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[1] Xenophon, *Anabasis*, iv. 5 (trans. Dakyns).

The entrances to the subterranean dwellings are in every case inside private houses. Your host takes you into his back premises, which extend themselves into an aperture like an enlarged rabbit-hole down which it is necessary to crawl upon hands and knees until the entry proper to the settlement is reached. This is marked by a recess at the side of the passage in which there is a mill-stone. From an inner chamber this stone can be rolled into position, completely blocking the passage; only the central hole of the mill-stone remains, and through this a rifle can be fired. "From inside we used to shoot with a gun thorough the hole in the mill-stone and shoot the Turks," said a modern informant, and in the Middle Ages a captain of Timour Beg, who was sent to hunt out the cave-dwellers of this district, was shot with an arrow in similar fashion.

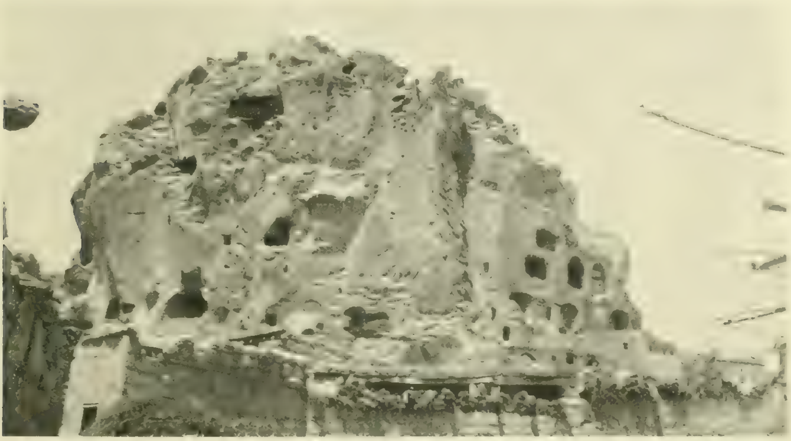

FIG. 2. ROCK DWELLINGS, UTCH HISSAR.

Beyond the mill-stone is a series of dwelling-rooms, churches, and store-houses (that below Mistí is reputed to contain as many as 400 dwellings), and the whole honeycomb is grouped round the village well, which in this waterless area is often very deep. Suvermes, "water is lacking," the Turkish name of one of these villages, tells its own tale, and at another, Malakopí, the level of the water is about seventy metres below the ground. The burrowed habitations are also carried to a considerable depth. At Malakopí there are no less than five series one below the other and each defended by a mill-stone door.

These subterranean warrens are called *καταφύγια*, "places of refuge," and the greater part of one of the villages, we were told, had taken refuge underground at the time of the Adana massacres. I can only hope that their cities of refuge may have enabled some of these Christians to survive the Great War. For with a sufficient supply of food they should be impregnable, except to blasting operations, for an indefinite period.

Not less interesting are two series of rock-cut dwellings above ground. The material of the Cappadocian plateau appears to consist of a very soft volcanic tufa with a thin protecting layer of harder rock on top. At two places there are cracks in this covering, and in these valleys the soft rock thus exposed has shown itself equally plastic to the agency of nature and the hand of man. One of them I have not had the good fortune to visit; the other, which runs from two masses of rock called Utch Hissar, "Three Castles," by the village of Matchan, the ancient Matiane, is the most remarkable natural spectacle I have seen. The rocks at Utch Hissar, thrown up perhaps by some volcanic agency, were honeycombed at some date unknown by human inhabitants. Weathering has now stripped the outer surface of the rock, and the oblong niches to be seen in Fig. 2 are rooms the outer walls of which have dropped away.

But more remarkable still is the valley at the head of which these masses of rock are placed. Here the absence of the hard integument has left the soft stone bare and nature has weathered it into a series of fantastic cones. Looking down the valley, one sees them not in tens but in hundreds. To add to the bizarre effect, their colour no less than their shape is unreal. Some are yellowish-white, some pink, some black, and some a dirty red. It is not unlike the mountain scenery in one of Giotto's frescoes come surprisingly to life, but yet more fantastic and strange.

The shapes, it will be seen, are chiefly conical, and in some cases where a fragment of the hard surface has survived, a "hatted" type has resulted, a block reposing on the pinnacle of the cone. Except for the rocks at Utch Hissar, none of their summits, though they may be eighty feet or more above their base, rise above the level of the valley's sides, and clearly they have been formed by erosion.

In these strange rocks the hand of man has carved fantastic dwellings and sanctuaries, and of the former some are still in use to-day. A feature of the more ambitious houses which struck me as interesting was the occasional imitation in carving of the architectural features of a true building. Thus doorposts, lintels, or arches which in a cave-dwelling are ornamental merely and not functional, are sometimes represented on the façades.

The churches in some cases contain paintings of interest, and one or two have yielded dates, though only, I believe, dates of restoration. When first these rocks were inhabited remains unknown. Almost certainly some of the churches go back to the tenth century A.D. It is tempting to think that yet earlier St. Basil, the great founder of monasticism, whose home was near by at Cæsarea, may have known of these valleys and have found in them the opportunity for developing the communal monastic life.[1]

Books Received

Continuous Wave Wireless Telegraphy. By W. H. Eccles, D.Sc., F.R.S. (The Wireless Press, 10*s.* 6*d.*)

The first part of a reasoned exposition of the science in simple form by an acknowledged authority. The fundamental principles of electro-magnetism are set forth in a manner immediately applicable to the study of Wireless Telegraphy. The physical properties of the ionic tube receive fundamental treatment. For students.

Map-Reading. By G. H. C. Dale. With a Preface by Lt.-Col. E. M. Jack, D.S.O., R.E. (Macmillan, 7*s.* 6*d.*)

A practical manual of map-reading. The subject is dealt with clearly and very simply. The problems are approached from the practical point of view. Recommended to the general reader.

The English Novel in the Time of Shakespeare. By J. J. Jusserand. Translated from the French by Elizabeth Lee. (T. Fisher Unwin, 4*s.* 6*d.*)

A book published some years ago which can be recommended to all lovers of the Elizabethan epoch. Like all M. Jusserand's books (he is the Ambassador of France at Washington), it is scholarly, brilliant, and entertaining.

Tidal Power. By A. M. A. Struben, A.M.I.E.E. (Sir Isaac Pitman, 2*s.* 6*d.*)

One of Pitman's Technical Primers.

Primitive Society. By E. S. Hartland, LL.D., F.S.A. (Methuen, 6*s.*)

A short work on anthropology in which the idea is developed that in the early stages of advance the mother was taken as the root of family life, and the power and position of the father were gradually developed at her expense.

Bernadotte and Napoleon, 1799–1810. By Sir Plunket Barton. (John Murray, 21*s.*)

A fully documented description of the life of General Bernadotte under the Consulate and under the First Empire down to 1810 when he was elected Prince Royal of Sweden.

Electrical Engineering. By Dr. T. F. Wall. (Methuen, 21*s.*)

A complete survey of the principles of electrical engineering by a lecturer in Sheffield University. It is intended for students in Universities, the advanced classes of Technical Schools, and as a book of reference for engineers.

Colour Photography

By R. A. Houstoun, D.Sc., Ph.D.

Lecturer in Physical Optics in the University of Glasgow

Practical methods of colour photography are based upon the theory of primary colours, and it is no use attempting to understand colour photography without first making a determined effort to master this theory. It can, however, be promised that the subject is not a difficult one, and that the properties of the primary colours and their mixtures form one of the most fascinating studies imaginable, equally interesting to photographers, artists, physicists, and the lay public.

At the outset we must emphasise and underline the fact, that mixing or adding together two coloured lights does not produce the same result as mixing or adding together coloured pigments, of the same colours as the lights.

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[1] A description of the underground dwellings below Cappadocian villages is given in Dawkins, *Modern Greek in Asia Minor.* Mr. Childs in *Across Asia Minor on Foot*, has described his visit to the neighbourhood of Utch Hissar. The churches of this region have been studied by French scholars. I have not seen *Eglises Souterraines de Cappadoce,* by the learned archæologist Father G. de Jerphanion, S.J., of the Université Saint Joseph, Beyrout. The first instalment of this definitive publication of their researches was due to appear in 1913.

Coloured Lights.—Let us suppose we have a white screen in a darkened room, and that by means of three lanterns we are able to throw three spots of light upon this screen. We can, for example, imagine we are in a theatre or music-hall, and that the three lanterns are situated in the front of the dress circle, each provided with its own operator, that the screen is on the stage, and that all lights are extinguished so that the theatre is perfectly dark. It is, of course, not necessary for the success of the experiment that it should be performed on this ambitious scale, but the description is probably easier to understand when the experiment is performed in this way, instead of by one of the methods used in the laboratory. We shall suppose that one of the spots or discs of light on the otherwise dark screen is coloured red, another green, and the third blue. Then by tilting their lanterns the operators can make these discs move across the screen and superimpose on one another. Usually the coloured light in theatres is produced by holding a sheet of coloured gelatine in front of the lantern, but the coloured gelatine employed in theatres is unsuitable for our experiment. The colours are not nearly saturated enough, i.e. not intense nor pure enough. Even the best green that the operator throws upon the villain contains a good deal of white in it. The red required for our experiment must be a pure red without any tint of orange, somewhat similar to the red of the railway signal lamps ; the green must contain neither yellow nor blue, and must be purer than the green of the signal lamps ; the blue must be an ultramarine with a good deal of violet in it.

Under these circumstances, if the red is superimposed on the green we obtain yellow. Strong red imposed on weak green gives orange, weak red on strong green yellowish-green. Green superimposed on blue gives peacock blue. Red superimposed on blue gives magenta, and red on a stronger blue gives purple. Red, green, and blue superimposed on one another make white. If white is dimmed, we get grey ; if orange is dimmed, we get brown. Superimposing white on any colour makes it paler. Thus by means of the three colours red, green, and blue we obtain nearly all the colours that occur in nature. They don't give us violet, but pure violets do not occur frequently in nature. So red, green, and blue are termed the three primary colours. Putting our results in the form of a table we obtain :

Red + Green + Blue = White

Red + Green = Yellow
Green + Blue = Peacock Blue
Blue + Red = Magenta

Red + Peacock Blue = White
Green + Magenta = White
Blue + Yellow = White

Peacock blue, magenta, and yellow are termed the three complementaries, since each of them combined with one of the primaries gives white. Peacock blue is sometimes referred to as minus-red, since it is the colour obtained by subtracting red from white, and in the same way magenta and yellow are referred to as minus-green and minus-blue.

Coloured Pigments.—We have now to consider the mixture of coloured pigments. We are all to a certain extent familiar with this subject owing to our experience with water-colour paint-boxes when children ; we then learned that yellow and blue make green, a result which does not agree with those set forth in the table above. Whence comes the contradiction ?

A red object—for example, a stick of red sealing wax —appears red because, when the three constituents of white light—namely, red, green, and blue—fall on it green and blue are absorbed, and red alone is reflected ; in the same way a green object appears green, because it absorbs the red and blue constituents of white light, and only the green constituent is reflected. If a red and a green paint are mixed, the mixture should therefore absorb all three constituents of white light, red, blue, and green, and consequently appear black, instead of yellow, as we would obtain on mixing red and green lights. A mixture of pigments gives only the colour which neither absorbs, not the sum of the two colours, as we obtain when adding lights.

This can be illustrated very prettily by means of the three complementaries, yellow, peacock blue, and magenta. Stained gelatine film can be obtained from Kodak, Ltd., Kingsway, London, E.C., exactly the colour of the complementaries, and when these films are combined two and two together, they give the colours of the primaries with very great accuracy. It is difficult to get paints or inks giving the colours of the complementaries exactly right, but three of Dove's waterproof inks, the yellow, the Prussian blue, and the carmine, are fair approximations. Small bottles of these inks can be obtained in most shops that supply draughtsman's materials. They are brighter and purer than the corresponding colours of the water-colour paint-box. The effect of mixing these colours can be studied best if they are added with a brush to a little water in the bottom of an egg-cup. If the carmine, which absorbs only green, is added to the yellow, which absorbs only blue, the mixture is red. If the yellow, which absorbs only blue, is added to the Prussian blue, the mixture is green. If a little carmine is added to the Prussian blue, we get an ultramarine blue similar to the third primary, and if we add more carmine we obtain purple ; but the results are not so good in this case, as the Prussian blue is not a peacock blue and absorbs some green.

It is the three complementaries, yellow, magenta, and peacock blue, that are used in three-colour printing, as may be seen by examining any three-colour print with a lens. First of all a yellow impression is made on paper ; then on the top of this a magenta or carmine impression, and finally on the top of this a peacock blue impression. Magenta on yellow gives red, peacock blue on yellow gives green, peacock blue on magenta true blue, while all three inks on the top of one another give black.

The Three Negatives.—There are many different processes of colour photography and variations of the different processes, some only of historical interest and others only of theoretical interest. The processes are still in course of development, and in the British Journal Photographic Almanac those interested will find references to investigations being carried on at present. But the practical methods hitherto developed which aim at a complete rendering of the colours all require three different photographic negatives. One highly successful method uses only two negatives, namely the Kinemacolor method of cinematography, but with two negatives the colours are not rendered so accurately as with three, and consequently three negatives are generally taken.

In taking an ordinary photograph, the picture is focused on the plate in the camera, and the plate is then exposed, developed, and fixed. The picture produced in this way is called the negative, because when it is held up to the light, it gives the rendering of light and shade reversed. The parts of the picture which should come out light are dark : the sky, for example, comes out black, so do white collars, while boots come out white. Now, in the case of an ordinary photograph, both visible light and invisible rays fall upon the photographic plate, red, green, and blue visible light, and ultra-violet invisible rays. But the ordinary photographic plate is sensitive only to the ultra-violet, the blue, and partly to the green. It is not sensitive to the red. Red letters on a dark background would not come out at all in the negative. It is because the plate is not sensitive to red that it can be developed in a red light. The single negative obtained in ordinary photography is produced by ultra-violet, blue, and some green rays all superimposing on the plate and producing a joint picture. Colour photography replaces this single negative by three separate negatives, one produced by each of the three primary colours, red, green, and blue.

The plates employed must be sensitive to red and green as well as to blue. So-called orthochromatic plates won't do ; they, like Kodak and Ensign films, are fully sensitive to the green, but not to the red. As a consequence of employing plates sensitive to red light, no red lamp can be used in the dark-room. The plates must be developed in darkness.

The three separate negatives may be taken (i) with an ordinary camera one after the other. In this case neither camera nor object must move during the three exposures. Or (ii), the three separate negatives may be taken simultaneously by means of a special camera provided either with three lenses or with an arrangement of mirrors. Or (iii), by means of a screen plate the three negatives may be taken simultaneously on the same plate with an ordinary camera ; this is the method employed in the Lumière and Paget processes.

Method used in Three-colour Printing.—The first method is probably the easiest to understand, so we shall describe it first. A quarter-plate camera, for example, is set up before a vase of flowers, and a red filter, a sheet of coloured gelatine contained between two glass plates, that transmits only the red rays, is placed in front of the lens. Then an exposure is made. Next the plate is changed, a green filter placed in front of the lens, and another exposure made. Finally the plate is changed again, a blue filter placed in front of the lens, and another exposure made. We thus obtain three negatives, one made by each of the three primary colours. Now let a glass positive be made from each of these negatives, and let these positives be used as lantern slides and projected on a screen by three separate lanterns, each in the colour in which the corresponding negative was originally taken. A positive is a negative made from a negative, and consequently has the correct rendering of light and shade. The arrangement of lanterns is similar to the one described in connection with the mixing of colours, only instead of projecting three discs of light we are projecting a red, a green, and a blue picture. If now the red, green, and blue pictures are superimposed, we shall have a picture of the vase of flowers on the screen in approximately its natural colours. This is referred to as the additive process of reproducing the colours.

Again, if we prepare half-tone blocks from each of the three negatives, and make impressions of these blocks on a sheet of paper, each in the colour complementary to the filter through which the corresponding negative was taken, e.g. the impression from the block made from the negative taken through the red filter is in peacock blue, then we shall have a print on the paper of the vase of flowers in its natural colours. This is the method employed in commercial three-colour work. It is referred to as the subtractive method of producing the colours.

It is unfortunately not possible in DISCOVERY to give an illustration in colours, but the adjoining ten diagrams which the reader can colour for himself may help to make the matter clearer. (1) is the object, a red, green, and blue flag nailed to a black stick, placed against a white background. (2), (3), and (4) are the negatives made through the red, green, and blue filters, i.e. by each of the three primary colours. (5), (6), and (7) are the positives made from these negatives. (8), (9), and (10) are the impressions made by the three blocks prepared from the three negatives.

When the three negatives are taken simultaneously, there is no difference in principle or procedure from the case in which they are taken one after another.

Lumière and Paget Processes.—The Lumière screen plate is an ordinary colour-sensitive plate covered with a layer of flattened starch grains. These grains are transparent, are coloured red, green, and blue, and are well mixed over the whole surface of the plate. The grains act as filters. They are invisible to the eye, but can be seen on examining the plate with a microscope. It does not matter where the filter is, as long as it comes between object and image. In the arrangement previously described it was in front of the lens; here it is on the plate. The light cannot get to the silver salt without passing through a filter. All the parts of the plate behind the red grains form a negative similar to that taken through the red filter in the method previously described. Only here the negative, instead of being continuous, forms a mosaic; it is mixed up with pieces of the other two negatives, and the area of each is less than one-third of the area of the plate.

After exposure the Lumière plate is developed and reversed. The image in the emulsion is converted into a positive by treating it with special solutions. The same plate that was the negative becomes the positive. We obtain, therefore, one plate which is a combination of the three positives produced by the method previously described. They are in the form of a mosaic, all mixed up. If this positive is put in a lantern and projected, it gives a picture of the original object in its natural colours. If it is held up to the window, it acts as a transparency giving a picture of the object in its natural colours. But there is no easy method by which it may be converted into a coloured print on paper.

The Paget method differs from the Lumière method in having the screen on a separate glass plate from the sensitive plate; consequently one screen may be used with a number of plates in succession. The screen is covered with little red, green, and blue rectangles forming a geometrical pattern. It appears colourless to the eye, but the rectangles can easily be seen under the microscope. They are much larger than the starch grains in the Lumière screen. The screen is held in the slide with its surface in contact with the plate. After the plate is exposed, it is developed, fixed, and a glass positive made in the usual manner. This glass positive is then combined with a screen, similar to that through which the original exposure was made. The screen and positive must be carefully adjusted, so that they are accurately in register. Each part of the positive must be opposite a rectangle of the same colour, as the exposure of the corresponding part of the negative was made through. When positive and screen are combined in this manner, they form a coloured transparency which can be viewed by holding it up to the window, or which may be projected as a lantern slide. There is no easy way of converting this transparency into a coloured print on paper.

Anyone possessing a camera that takes one of the standard sizes of plates can make coloured transparencies with a little patience by either the Lumière or Paget processes, and many amateurs dabbled in these processes in the days before the war. But the drawback is the impossibility of making coloured prints. And there is also a difficulty in obtaining suitable objects to photograph. An English city contains comparatively little colour; perhaps the only bright colour in a street is a red letter-box or the coloured side-boards of a tram-car. And in the country, except at certain seasons, the colours are never saturated. So possibly the best rendering may be given by a sepia monochrome slightly tinted by hand.

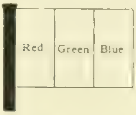

FIG. 1

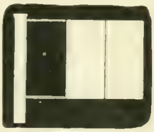

FIG. 2.
Negative through red filter.

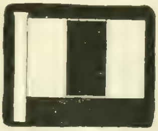

FIG. 3.
Negative through green filter.

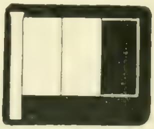

FIG. 4.
Negative through blue filter.

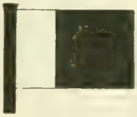

FIG. 5.
Positive for projection in red.

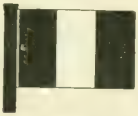

FIG. 6.
Positive for projection in green.

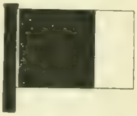

FIG. 7.
Positive for projection in blue.

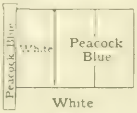

FIG. 8.

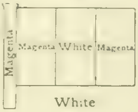

FIG. 9.

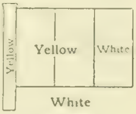

FIG. 10.

The three impressions in three-colour printing.

The method used for three-colour printing is, of course, the method by which three separate negatives [illegible]. The most interesting developments of this method are taking place at present in cinematography. Here it is no disadvantage not to be able to obtain a coloured print, and three lenses are not necessary to project the three coloured pictures. One lens can project all three one after another, so rapidly that they fuse into one. Similarly the three pictures can be taken in rapid succession by means of the same lens, and the elaboration of apparatus and difficulties of registration can be avoided. So that the prospects of success are greater here.

Colour photography is a subject on which the textbooks become out of date. It has been impossible in this article to do more than give an outline of it. Probably the best method for the amateur to obtain further information is by studying the literature supplied by the photographic dealers.

Orthopædic Surgery

By A. B. Appleton, M.A., M.R.C.S.

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(*Continued from May No., p.* 122)

We find that already in the time of that pioneer surgeon-anatomist Hunter, when Mrs. Mabb drove her carriage and four into London[1] "to take charge of the dislocated limbs of the nobility and gentry," the medical profession was putting behind it the old secrecy which had characterised the alchemists and healers of old. It is only the pursuit of truth for truth's sake, and the publishing abroad for all to know of every treasure as it is unearthed, that has rendered possible modern medical knowledge and science. As time goes on, the difference of motive between quack and professional becomes still more marked, but even now a large proportion of educated men and women are ignorant of the altruistic spirit behind the spread of medical knowledge, and they readily condone the reticence of the quack. Such reticence, however, if there were anything to conceal, would be the enemy of all progress.

Diagnosis of the nature of joint disability is, then, of essential importance; if the bone-setter could form a rational diagnosis, he would avoid the cases which are made worse by manipulation; he would cure the appropriate cases only, and avoid the disasters which are inevitable with empirical methods.

Thorough manipulation is appropriate for cases where adhesions are present. But very similar symptoms arise in a knee where the patient is suffering merely from loss of power in wasted thigh muscles. For these the orthopædic surgeon will not "manipulate"; he will prescribe a course of Graduated Contractions. Again, a torn "cartilage" or ligament may be present; if so, Graduated Contractions will not cure; but the condition may heal spontaneously after replacement, or it may need operation to remove the torn fragment. But if, after healing, the tear is reopened, there will this time be a greater liability to adhesion formation, and to weakening of the joint from fluid effusion, and this is aggravated every time the "cartilage comes out." A clear understanding of these circumstances requires the orthopædic surgeon of to-day to recommend operative treatment after trial has shown that replacement of the torn cartilage by manipulation has not resulted in thorough repair.

As in other spheres of surgery, we find in "diagnosis before treatment" the keynote of success; the nearer we can approach this ideal, the better shall we succeed. Owen Thomas, the son of an unqualified practitioner, spending his boyhood observing his father's treatment of joint troubles, later making a special study of bone-setters' methods, and noting their failures and successes, deliberately concluded that a knowledge of causes was necessary; that as a bone-setter he would never cure all cases, and that he must learn wherein the differences lay that he might cure all of them. Since his pioneer work, the mechanism of the knee-joint and the manner in which derangement occurs have become much more fully understood from the anatomical investigations of Hey, of Leeds, and Goodsir in Edinburgh. If only all the "medical practitioners of England had been familiar with the observations of William Hey, and grasped his method of treatment," says Dr. Keith,[2] "bone-setters would not now be flourishing in the West End of London."

There is another method of dealing with adhesions other than "manipulation," one which is most particularly applicable to tough or extensive adhesions, to contracted scars or to fibrous changes in muscles (ischæmic and other contractures). It has developed out of the methods of Owen Thomas, and is illustrated in Fig. 2,[3] showing the later stages of a successful slow prolonged stretching extending over weeks. Such "continuous splintage" has been found to be vastly more effective for certain types of stiffness than the immediate forcible manipulation previously discussed.

The caliper splint, an offspring of Thomas's knee splint, has provided a means of making a lower limb functionate even when an incompletely repaired fracture is present, and when the full weight cannot be borne upon the limb. The side-bars are of just such a length that when the man sits on the upper end, a *small* part (or none if desired) of his weight is transmitted through his own leg to the heel of the boot, and the splint prevents any shortening of the limb. Transmitted pressure, thus provided, is found to exert a very beneficial effect on the rate of bone-repair; for even a healthy bone becomes fragile if it is not permitted to withstand the stresses for which it is constructed. Elmslie[1] in London, and more recently Els of Bonn, have published cases in which bone-grafts have themselves grown to a much larger size from the effect of transmitted stresses.[2] It is of advantage, then, to the fractured bone, as well as a convenience to the patient, that he should get about at an early date in a caliper splint. It is of great use for similar reasons—the partial maintenance of natural functions—in other conditions besides fractures.

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[1] Quoted by Dr. Arthur Keith, reference No. 2; see also p. 308 of the same work.

[2] See reference No. 2, pp. 319 and 323.

[3] See reference No. 1.

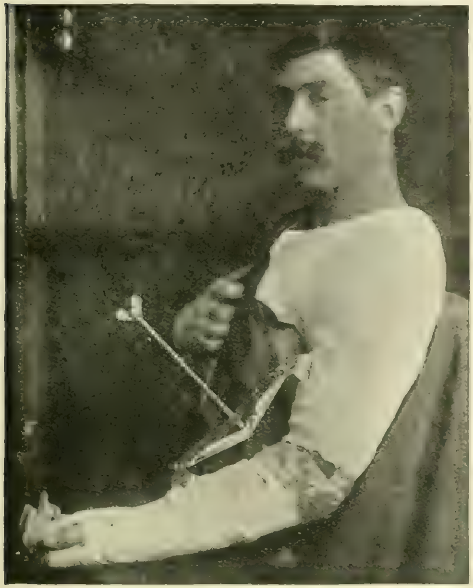

FIG. 2.

THE PATIENT, BY TURNING THE SCREW, HAS GRADUALLY STRAIGHTENED OUT HIS ELBOW.

(Reproduced by permission of the Oxford Medical Publications.)

The treatment of limbs after injury to nerves has fallen within the scope of the orthopædic surgeon on account of the deformities which follow the consequent unbalanced muscular forces,[3] and on account of the need for special treatment to the muscles put out of action by nerve injury. Apart from repair of the nerve, a grave problem is presented by the injury inflicted on a muscle by complete loss of activity, the wasting of muscles being in these cases extreme. Nor was it (till recently perhaps) a simple matter to circumvent this secondary effect of nerve injury. Muscles which have been cut off from the central nervous system show a series of changes which has been known as the "reaction of degeneration," a change which, it has been discovered, is in reality an increased minimum duration of the effective electrical stimulus to contraction. A normal muscle is sensitive to electrical stimuli of very short duration. If one (electrical) pad is placed on the "motor point" of an arm muscle, and the other terminal moved about over the belly of the muscle until the optimum position is found, an impulse lasting only $\frac{1}{24000}$ second of a 100-volt potential will cause a definite contraction. But after six weeks' deprivation of impulses through its nerve, this muscle

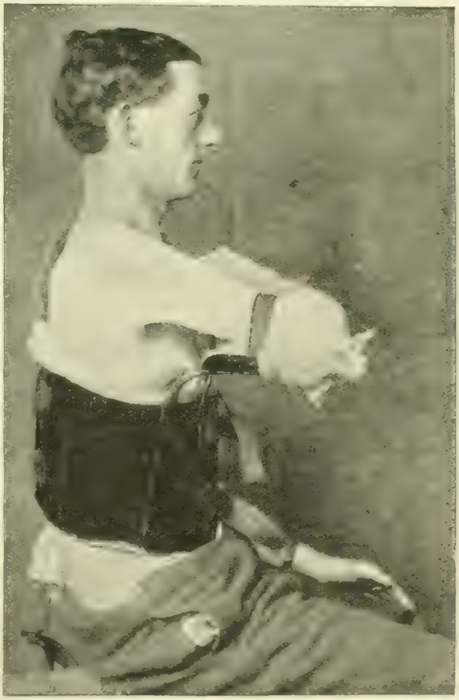

FIG.

ABDUCTION SPLINT FOR USE WHEN THE ARM CANNOT, OWING TO NERVE INJURY, BE LIFTED FROM THE SIDE.

(Reproduced by permission of the Oxford Medical Publications.)

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[1] See reference No. 3 at end of article.

[2] Bond, of Leicester, and Huntingdon, of California, published the first cases in 1905.

[3] See Fig 3.

will a muscle respond to a stimulus lasting $\frac{1}{100}$ second. An important practical result of this influences our procedures for treatment. Such a muscle will not, in fact, respond at all to the average effective impulse derived from a faradic coil, lasting $\frac{1}{1000}$ second; we are therefore precluded from the use of an ordinary coil for the purpose of giving Graduated Contractions, which would have been an ideal method of maintaining condition in a muscle. It has not yet been ascertained how long it is necessary for a nerve-path to be blocked in order to render a muscle insusceptible to the faradic stimulus; during the period, however, in which a nerve whose two cut ends have been sewn together is in process of recovering its functions, there is a period of months during which a long impulse, such as that ordinarily obtained at make or break of a galvanic current, is necessary for contraction. During this period, then, daily stimulation of the affected muscles is necessary, the galvanic current being employed until response is obtained with the faradic current; both are then employed for a time till finally the faradic current is employed alone as described under the procedure for Graduated Contractions. Resisted exercises form the last stage of treatment for the recovering muscles upon the return of voluntary power.

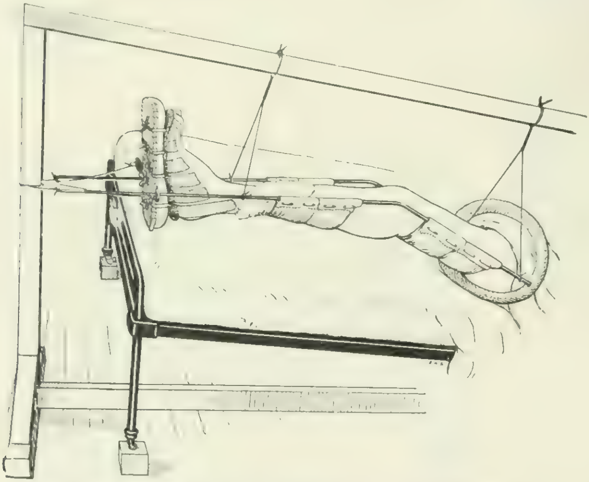

FIG. 4.

TREATMENT OF COMPOUND FRACTURE OF LEG ON THOMAS'S SPLINT SLUNG FROM A BALKAN BEAM.

Extension is made from a Sinclair's Foot-piece.

(Reproduced by kind permission of Messrs. Baillière, Tindall, and Cox.)

The same considerations apply, then, to the care of a limb immobilised from paralysis through injury to a muscle-nerve as apply to the care of a limb with fractured bone. There is the same liability to adhesions of joints, of muscle-tendons to their sheaths, and of muscle-wasting as with any other cause of immobilisation; but the muscle-wasting is infinitely more serious, the muscles require a special type of electrical stimuli for their contraction, and the period of treatment must continue till the nerve has been repaired and is able to conduct voluntary impulses.

Exhaustive study, by the late Dr. Lewis Jones, of the problem of obtaining a standardised instrument as regards impulse length voltage and rate of interruption, which would supply impulses of any required length, resulted in the production of his condenser apparatus, which in turn has undergone some slight further modifications. It is only by such an instrument that any satisfactory investigation of the exact condition of a muscle is possible. With its help we can detect defect in a muscle which appears to respond well to voluntary effort; we can ascertain improvement in a muscle which is still unable to respond to impulses from an induction coil. It completely alters, in fact, our position as regards the investigation of degenerative changes in muscles following enforced inactivity.

Methods of repair of nerve have of late received much attention, but must be here passed over with scant attention. The problem of making up for a gap of several inches in a divided nerve has been a constantly recurring one in war injuries, and the value of nerve-grafts is still subject to much discussion. Considerations as to the method of repair of nerves, the downgrowth from the proximal portion into the peripheral portion (which serves merely as a pathway to conduct it to its destination) when the cut ends are brought together, makes it likely that grafts serve a similar purpose, conducting the new outgrowing fibres into the separated distal part of the nerve. It is possible that other devices may prove quite as successful. As implied above, long periods are found to be required for the fresh outgrowth of nerve fibres from the cut end along the old path, up to eighteen months in the leg, depending on the distance they have to travel before reaching their end-organ in the muscle. The nerve-fibres appear to be absolutely dependent on their connection with the central end for function, growth, and life itself.

There are within sight at the present time great possibilities for the use of bone-grafts. We can transplant pieces of bone, with the correct technique, cut them to any required shape, and implant them after the manner of a cabinet-maker's art, with the practical certainty that they will live in their new surroundings. Absolute freedom from germs is a *sine qua non*, especially in bone-surgery, and it requires "surgically clean" surroundings for its success; but these conditions are attainable, and the method is frequently applicable to the repair of fractures. Whether dead bone will succeed as a graft as well as live bone is a point requiring investigation; certain facts point to the purpose of the transplanted bone as no more than a scaffolding for the ingrowth of neighbouring live bone, in which case boiled pieces of bone derived from a sheep should be as successful as live bone from the shin of the patient. A curious fact has come to light, however; a bone-graft is alive three months after transplantation, a date which seems early for the ingrowth into it from its surroundings of live bone-cells. Yet such a graft undergoes active repair at this date, after fracture, as only live bone can do. The explanation of such facts and the possible sources of such ingrowing bone-cells, if any, provide much scope for further investigation.

The subject of bone-grafting, so highly developed as a surgical technique by Albee in America, with his twin motor saws, etc., cannot be dismissed without reference to his treatment of spinal tuberculosis. Here absolute immobility is the goal of all methods of treatment, in the hope that the disease will then become quiescent. Plaster-jackets and the recumbent position in bed have long been tried, without complete satisfaction. But it would seem that the bone-graft, long enough when adherent to the spine to make it a rigid column, will help to solve the problem, which is, it must be said, one of the most difficult in orthopædic work. With the mention of the "plaster bed," a "bed" accurately moulded on to the patient's back, and in which he can lie without disturbance for a month at a time without danger of pressure-sores forming such as occur so easily in a bed-ridden patient, we must dismiss spinal tuberculosis. Its importance and its difficulties are not to be measured by such brief consideration as ours.

Difficulties also surround the provision of suitable artificial limbs for amputation stumps prepared by the brilliant kineplastic methods of the Italian surgeons. Movable nobs and pulleys are prepared from the live tissues themselves, the pull of an individual muscle being "harnessed" to the nob and so rendered capable of transmission, for example, to the thumb of an artificial hand. These are more successful when a small piece of bone can be incorporated in the "nob," to render it more substantial, but the gravest limitation lies in the difficulty of designing suitable artificial appliances.

The value of baths of different temperatures, of whirlpool baths, must be mentioned when effects upon the circulation are desired or when either stimulating or sedative effects are required. They form a useful preliminary to the administration of massage. Extensions in the employment of electricity in various forms must be similarly passed over without further consideration.

The rise of orthopædic surgery, as we have seen it, has been the outcome of anatomical studies of the exact arrangement of parts, of experimental investigations as to the behaviour of muscle, bone, and other tissues under normal and abnormal conditions, and the application of knowledge so gained to the treatment of an increasing variety of disabilities. Exact diagnosis precedes surgical treatment just as education in the use of restored or reconstructed parts must follow it.

Solid foundations are being laid where once there was a house built upon sand; but the building of the superstructure has scarcely yet begun.

BOOKS OF REFERENCE OR FOR FURTHER READING

(1) *Treatment of Joint and Muscle Injuries.* By W. Rowley Bristow. (Oxford University Press, 1917, 6*s*.)

(2) *Menders of the Maimed.* By A. Keith, M.D., F.R.C.S., F.R.S. (Oxford University Press, 1919, 16*s*.)

(3) *The After-Treatment of Wounds and Injuries.* By R. C. Elmslie, M.S., F.R.C.S. (J. & A. Churchill, 1919.)

Rising and Falling Prices—and a Remedy

By Arthur R. Burns, B.Sc. (Econ.)

I

ECONOMICS, the science that treats of the facts and conditions of the material side of daily life, seems a somewhat unpromising direction in which to seek discovery with all the essential suddenness of advent and revolutionary effect with which it is associated in the physical sciences. In spite of this, something very much akin to discovery, or perhaps, more properly, invention, has been made by Professor Irving Fisher, who has been working for some years at the Yale University on the problem of money and the devising of a scheme to eliminate the serious inconveniences of rising and falling prices.

The organisation of society is to-day so vastly more complicated than in the days when money was first invented that, before we can fully appreciate either the problem Professor Fisher has been attacking, or the merits of his invention, it will be well to look back to those early days. We shall then be better able to realise how much has now come to depend upon the [illegible] of currency and how money has been bearing its burden.

The invention of money was made far back in antiquity and originated in the great difficulties that arose under a system of simple barter. Any measure of freedom and ease in the exchange of goods made it necessary for some commodity, or commodities, to be commonly acceptable in exchange for things which individuals desired to acquire. Although in various times and places many different commodities have passed as currency, certain metals have proved most suitable for this purpose, and gold and silver—the "precious metals"—have been the most widely used. Both have been eagerly sought after for purposes of personal adornment, and their comparative scarcity has given them a high value. The weight and bulk of these metals needed to carry through normal transactions is thus rendered reasonably convenient. While both metals have been used for currency purposes from early times, at the commencement of the Christian Era, and for many centuries, silver was the metal more commonly used in England and on the European continent. During the nineteenth century circumstances (including the discovery of supplies of gold in California, Australia and, later, in the Witwatersrand) caused gold to gain much in popularity for currency purposes. For a period of about forty years prior to the outbreak of the Great War, gold was the basis of nearly all currencies in the world.

While, before the war, gold was in circulation in this country as a currency, in reality it was used only to a very small extent in the settlement of private and, to an even less extent, of business transactions, in proportion to the amount of business done. For transactions within the United Kingdom cheques were used for the settlement of the greater volume of debts. In the settlement of debts due to and by persons outside the United Kingdom, i.e. in settlement of foreign trade transactions, the bill of exchange largely fulfilled the functions of the cheque at home. In addition, it fulfilled other functions with which it is not here necessary to deal.

When the cheque was invented in this country by the goldsmiths in the City of London in the seventeenth century, it was merely an order by a customer instructing the goldsmith to pay a creditor of the customer a certain sum out of the money left with the goldsmith for safe keeping. The goldsmiths found that, although customers were always withdrawing and depositing money with them, yet, on balance, there was always a considerable sum which was not, in the ordinary way, required by customers. As a result, they began the practice of lending out for their own profit so much of this steady balance as they considered it safe to part with. If they lent out too freely they found themselves, sooner or later, with insufficient ready money to pay a customer's cheque and had to suspend payment. In this practice of lending balances commenced the practice of banking as distinct from the provision of safe deposit facilities for money. To-day the relending of customers' money has developed very far in this country. Bankers lend part of the funds entrusted to them by their customers to other customers—by allowing these latter to draw cheques upon them for an amount greater than the deposits of the borrowing customer, i.e. by allowing overdrafts. Money is also lent by them in other ways—by purchasing securities and by providing funds to persons whose function it is to relend them in the facilitation of trade transactions (by discounting and lending on bills of exchange). If it had been compulsory to use gold in the settlement of all debts, trade upon the present scale would have been impossible, for there was sufficient gold in this country in 1914 to pay only a very small percentage of the amounts which bankers owed their customers. Bankers still endeavoured to arrange their business in such a way as always to be able to supply gold when it was demanded, but now, in the knowledge that any great demand for gold was improbable, they relied mainly upon being able to get gold from the Bank of England, which relied largely upon its power to set in motion influences that would check the demand for gold. To attempt the task of paying out simultaneously in gold all the sums it owed would have been attempting the impossible.

Thus, for all practical purposes, cheques formed a very great addition to the gold currency of the country. In the days before the goldsmiths relent the balances in their hands, cheques, if passed from hand to hand, merely represented a portion of the gold in the vault below the goldsmith's shop, and were not an addition to, but rather a temporary substitute for, the gold coins. The amount of this addition to the gold currency is decided by bankers when they determine the extent to which they will relend the funds in their hands. They cannot, of course, lend more than the total deposits with them; they dare not lend nearly all these deposits—or how are they to meet their customers' demands day by day? They must clearly make some decision—endeavouring to lend as much as possible in order to make as much profit as possible and yet always keeping ample funds to meet all demands.

Bank of England notes were also, before the war, an important part of our currency system; but as all notes in excess of an amount fixed by an Act of Parliament of 1844—and termed the "fiduciary issue"—were represented by actual gold at the Bank, these notes were in the nature of mere safe deposit receipts for gold in the same way as the original cheques on goldsmiths.

Small change moneys of silver, nickel, and bronze are accepted only to a limited extent, and may, therefore, be ignored for the purposes of the present article.

Having now discussed the elements which go to make up the currency supply of the country, we may pass on to the relation between this supply and prices in the country. In most transactions money forms one side of the bargain—when an article is sold for money it is just as logical to say that the money has been sold for the article. The most obvious and generally applicable way of making a commodity cheap is to increase the amount available for exchange. This applies equally to money, and if the quantity of money available be increased, then its value will tend to fall, or, we shall say prices are rising—for we shall be compelled to give more of the less valuable pounds to obtain a commodity than before the change took place. If, however, the amount of work to be done by the money (the amount of goods and services to be purchased) be also increased, then a neutralising influence would come into force and the result of the two opposing tendencies would depend upon the quantities concerned on either side. On the other hand, by decreasing the amount of money available, the purchasing power of the money would tend to be increased and prices tend to fall.

There is also another way in which monetary conditions may affect prices. Money is used over and over again—every recipient again paying it away in a greater or lesser time. It can easily be seen that by a general increase in the rate at which people " turn their money over," a smaller amount of money may be made to do the same work as was done by a larger amount when the circulation was sluggish—or, if the rapidity of circulation be increased without any reduction in the amount of money, the effect will be the same as if the amount of money had been increased and a rise in prices will result.

In actual fact, the assumption above made that the amount of goods for sale shall remain unchanged cannot, of course, be made. General prices are thus determined by the quantity of goods and services to be sold on the one hand and the amount of money and the rapidity with which it is being turned over on the other. We have already seen above that money must be understood to include not only gold, but cheques and bills and all instruments used for making money payments and which pass freely as currency. We have also seen that the amount of the cheque circulation (or, in its more general name, the volume of credit) is determined by bankers, as they decide from day to day how much of their customers' funds they will relend. If bankers choose to allow very large overdrafts to their customers, the customers would be given great power to purchase and would drive up prices. If, however, the bankers did this, they would not only cause prices to rise, but they would also, when the time came to honour the cheques, have to face heavy demands upon themselves, and would ultimately find that only a very small portion of the funds originally lent to them by their customers was in a form in which it could be used to pay back these customers, should they require their money. Thus while the bankers can and do, by increasing and decreasing the amount of purchasing power available, cause increases and decreases in prices, they are always held back by the fact that they must keep a reasonable and safe proportion of their funds in a " liquid " condition, as we explained above.

An increase in the amount of gold available increases purchasing power in the same way as an increase of credit, but such an increase has also a further and secondary tendency to increase purchasing power, owing to the fact that credit is based ultimately upon gold and the increased reserve of gold acts also as a basis for further credit.

The price of any individual commodity, however, may be influenced by a great number of factors, which may affect either the supply of that commodity or the demand for it. The price of wheat may well be affected by weather conditions in the wheat-producing areas, or changes in the habits of the people involving a greater or less consumption of wheat. All prices are, however, expressed in the terms of currency, but sellers accept currency for their goods or services only because they know that they can obtain the goods or services of which they are themselves in need in exchange for the currency. The real price which they get is, therefore, the goods or services which they can obtain by spending their currency. This is determined, however, not only by the factors which decide at what price they can sell their product, but also by what they can obtain in exchange for the currency in which they are paid. In dealing with any one commodity, it may often be difficult to decide whether changes in price have been due to changes in the conditions of the supply of or demand for the commodity, or changes in the purchasing power of the currency. If this purchasing power falls, i.e. if general prices rise, sellers will find that, unless they raise their prices expressed in currency, the real prices they are getting are falling and they " cannot live." A rise in the purchasing power of the currency will raise their real prices and competition will tend to force them to reduce their money prices.

Until comparatively recently there has been no satisfactory method of ascertaining whether changes in prices have been due to changes with regard to each commodity or changes due to currency conditions. A convenient method of doing this is now to hand in the familiar " index number." The principle upon which the index number depends is that, if we find that the prices of a number of commodities, all affected by different supply and demand influences show a common tendency to rise or to fall, then it is fairly safe to assume that the change has been in the currency in which the prices are expressed, and not in each commodity.

The general idea is well illustrated by the fact that it was once believed that, because the stars all appeared to move across the sky, the earth was at the centre of the universe and the heavenly bodies moved round it. It is now thought more reasonable to suppose that it is we who are moving by reason of the revolution of the earth and that the stars are relatively fixed.

(*To be continued.*)

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Stabilising the Dollar, by Irving Fisher. (Macmillan, 18s.)
The Purchasing Power of Money, by Irving Fisher. (*Ibid.* 12s. 6d.)

The Place and Power of the Cerebellum

By D. Fraser Harris, M.D., D.Sc., F.R.S.E.

Professor of Physiology, Dalhousie University, Halifax, N.S.

THE functions of the cerebellum were for a very long time a mystery ; our anatomical knowledge of it was so much more detailed than the physiological, a state of matters that has been the usual rather than the exceptional as regards most organs of the body.

The cerebellum, which is below the cerebrum, and protected from its pressure by a stout sheet of connective tissue, the tentorium, is composed of two lateral portions, the hemispheres, and a single central mass, the vermis. Each half of the cerebellum is connected by many nerve-fibres to the cerebrum above, to the spinal cord behind, and to the brain-stem below, the superior, inferior, and middle peduncles respectively.

The cerebellum sends nerve-fibres to the cerebrum by a crossed path, and the cerebrum sends fibres by a different and more roundabout crossed path to the cerebellum. These reciprocal relations are of such a kind that when one-half of the cerebrum, say the left, does not develop, the opposite, or right, half of the cerebellum remains undersized.

The cerebellum is also abundantly related to the body through certain tracts of the spinal cord, the chief connection being with the skin and muscles of the body by tracts which do not cross ; that is, the left side of the body is represented in the left half of the cerebellum and the right in the right. The right half of the cerebellum is, therefore, connected with the left half of the brain, but with the right half of the body. Now, it will be remembered that the left half of the brain governs the right half of the body. The muscles of the head, neck, and trunk are represented on both sides of the mid-line in the central parts of the cerebellum, those of the limbs in the lateral parts.

The cerebellum is late of appearing in the nervous system as we ascend the animal scale. As one might expect, it is relatively very large in the birds, creatures to whom the maintenance of an accurate balance is so very important. The fishes, for instance, have the cerebellum better developed than have the reptiles, in which group it cannot have much functional importance.

Let us now try to make out what these various connections of the cerebellum to other parts of the nervous system mean. In the first place, injuries to or diseases of the cerebellum do not produce any impairment of a person's sensations. Animals from which the entire cerebellum has been removed do not suffer any loss of sensation. A man with congenitally undeveloped cerebellum has no diminution of delicacy of sensation. The cerebellum is, therefore, not the physical basis of the elaboration of sensations, nor does it aid in that process.

But numerous nerve-impulses travel over the paths which reach the cerebellum through the spinal cord from the body—impulses, therefore, which are afferent but not sensation-producing or sensificatory. The cerebellum *re*ceives but it does not *per*ceive. Muscles, joints, skin, viscera, and those curiously complicated " semicircular " canals, a part of the internal ear which have to do with balancing, all send their impulses to the cerebellum. But they also send impulses which go to the cerebrum and give rise to sensations of different degrees of distinctness. So that the state of matters seems to be this : while certain organs send impulses to the brain to contribute to consciousness, these same organs simultaneously send impulses to the cerebellum, which do not give rise to consciousness.

We cannot, therefore, speak of the cerebellum as being " aware " of anything ; there is no simple word to express what exactly the cerebellum does as regards afferent impulses. It receives them from many parts of the body and " works them up " or correlates them without their arousing consciousness at all. The cerebellum receives afferent but not sensificatory impulses, and dealing with them subconsciously, relates them to outgoing impulses.

Let us in the next place see what is the state of matters on the efferent or motorial side. When a portion of the cerebellum is injured in an animal, the animal does not suffer from paralysis of any muscles, but from a clumsiness of movement and an awkwardness of muscular action. When this awkwardness is brought out in the arms as a test in clinical medicine it is called " adiadochokinesia." The muscles have, indeed, rather less tone than before (atonia), and their movements are somewhat inco-ordinate, or ataxic.

If the entire cerebellum has been removed, the animal cannot maintain its balance either in a state of rest or of motion ; and if one-half of the organ has been removed, the animal has tremor of the muscles on that side and tends to fall towards the side of the defect.

In man, injury to the cerebellum, according to its gravity, leads to more or less extensive inco-ordination of muscles, or ataxia, especially in the legs, so that the equilibrium of the body becomes unstable, whether the body be at rest or in motion. His muscles are not paralysed, and he can move them voluntarily as before ; but if the cerebellar disease be at all serious, he walks with a staggering gait like a drunken man and strives to keep his legs far apart because this widens his base of support. This, of course, he does consciously ; his straddling gait is the conscious compensation for the results of the subconscious irregularity in the cerebellar mechanism for the maintenance of the equilibrium of the body. The gait in cerebellar ataxia is characteristic, the head lags behind the torso and the torso behind the legs. Although, then, the cerebellum is not the seat of awareness of bodily states, and not the organ which originates bodily actions, yet it seems to be an important organ in the co-ordination of muscles which steady the body whether at rest or in motion (static or dynamic equilibrium).

The cerebellum sends no motor impulses to muscles or to any other " effector " organs, as far as is known. Efferent tracts do, however, leave it, not for the muscles directly, but for them indirectly via the cerebrum. The cerebrum controls the muscles, decides whether they shall merely leave the body at rest or balance it as it moves about ; but all the time the cerebellum, in its turn, apparently controls or influences the cerebrum. For instance, it has been noticed that when the cerebellum has been injured, the cerebrum is apt to put forth either too little or too much nerve-energy, and so produce ataxia by deficiency (adynamia), or ataxia by excess (over-action, over-compensation).

The study of the behaviour of a large intelligent animal which has suffered the loss of one-half of its cerebellum is instructive. Let us suppose that an adult dog has had its left cerebellar hemisphere removed ; for the first few days it cannot stand properly, but falls over on the left side. The eyes are not at rest, but oscillating ; the muscles of the left side are tremulous and rather weaker than usual, though by no means paralysed. By degrees the dog gets better ; the tremors are less severe, and finally he learns that he can prevent himself falling over if he walks towards the wall and leans up against it. This is intelligent compensation for the defect of impaired maintenance of equilibrium ; it is possible only because the animal's cerebrum is still intact.

Again, a dog with only half of the cerebellum intact, if thrown into the water, will swim more or less like a normal animal. It is noticed, however, that the dog does not go in a straight line, but in a curve which bends towards the sound side. The reason for this is interesting : dogs swim not like men, but by " grabbing " the water with their fore-paws. The muscles on the sound side, having more tone than those on the other, allow the paws to catch hold of the water better, with the result that if it is the left cerebellar half that is gone, the dog swims away towards his own right.

Muscles in human cerebellar disease are not paralysed, but they are tremulous and to greater or less extent show diminished tone and force (adynamia). The same facts may be brought out by another device : if the dog above referred to be now made to walk on the hard ground, he is seen to be deviating towards his own left. This is because the right-sided muscles, having the better tone, get a better push-off from the ground than do the opposite ones, and so in time cause the animal to walk away from the straight line.

A curious thing was noticed about the dog made to swim. After a certain number of trials it was learning to swim straight. The dog found that it could steer itself by means of its tail. It used its tail as a rudder, curved in this case towards the left in order to bring its body over to the side from which it was drifting. A dog, one of whose cerebral hemispheres has been removed, cannot do this.

But the cerebellum receives impulses from regions other than the periphery ; it receives them also from the cerebrum. When the cerebrum is sending down nerve-energy to the muscles to maintain their tone or put them into activity, it sends simultaneously some energy over to the opposite half of the cerebellum.

The meaning of these various paths into and out of the cerebellum is probably somewhat as follows :

The cerebellum is informed of the state of tone or of contraction of the entire musculature of the body at any given instant ; if, for any reason, it is necessary to increase that tone, the cerebrum has to emit fresh impulses, but just how intensely it must do so will depend on the amount of innervation which is sent over to it from the cerebellum (augmentor function) ; if, however, from any cause the cerebrum has been innervating the muscles too intensely, then it receives impulses from the cerebellum to restrain the intensity of its energy (inhibitory function).

The cerebellum is, as regards the cerebrum, a kind of " centrifugal governor " : if the cerebrum is not doing enough in the way of innervating muscles, the cerebellum intensifies its activity ; if it is doing too much, it cuts it down, and all this below the level of consciousness.

The cerebellum is, then, not so much an organ for maintaining equilibrium as an organ corrective or regulative of the intensity of central motorial innervation. It is functionally an intermediary between the muscles and the cerebrum, but in order to be such it must be constantly informed both of the state of the muscles and also of the cerebrum in regard to the output of its energy from the latter. These conditions are fulfilled by the numerous afferent paths to it from the muscles and from the brain.

Reviews of Books

English Philology in English Universities. An Inaugural Lecture delivered in the Examination Schools. By HENRY CECIL WYLD, M.A., B.Litt., Merton Professor of English Language and Literature in the University of Oxford. (Clarendon Press, 1921, 2*s.* 6*d.*)

This inaugural lecture breaks new ground in its examination of the state of research in English philology and in its statement of policy with regard to the teaching of that subject at British universities. The pronouncement, coming as it does from perhaps the most distinguished living English philologist, merits the closest attention from all those interested in the teaching of language, and in the propagation of linguistic study. Professor Wyld holds, and we think he holds rightly, that all is not well with University methods and curricula when they do not succeed in inspiring " students with the desire or the capacity to make any serious contribution to our knowledge of any of the difficult special problems connected with " O.E. and M.E. dialects, and their distribution, or with their grammar and phonology. "Concerning the vital question of the origin and development of the literary dialect, which emerges during the M.E. period, there is hardly a single contribution by an English writer." Sweet and Ellis laid the foundations of the study of N.E. pronunciation and of the history of English sounds, but " nearly all the recent work on the modern period has been done by foreigners "—Horn, a German, Professor Jespersen, a Dane, Professor Ekwall and Dr. Zachrisson, both Swedes. Of living English scholars, among the younger men Dr. Chambers and Professor Sedgefield are producing solid work on textual lines ; Professor Mawer has recently published a very notable contribution to the study of place-names, while Professor Wyld himself is revolutionising opinion about the distribution of dialect-features in M.E., and constantly making additions to the knowledge of phonology. Finally, the Oxford English Dictionary, its editors and assistants are on the verge of completing the greatest modern monument of English philological study. But even, if to these we add the names of the scholars of the last generation, notably those of Sir Henry Murray, Professor Napier, Professor Craigie, Dr. Bradley, and Professor Wright, it is clear that the promise of the work of Sweet, Skeat, Morris, and Ellis has not been fulfilled.

Mr. Wyld evidently favours the separation of the School of English Literature from the School of English Language, and holds that it is " beyond dispute that the studies of literature and philology appeal respectively to different types of mind." Of this the present writer is by no means convinced, especially in the earlier stages. Indeed, Mr. Wyld might himself be taken as an example of the scientific philologist with strong literary bent and critical discrimination. Moreover, as things are, and must inevitably for some time remain, it is impossible to discover budding philologists before they come up to a university. Consequently it is desirable that all students in the English Honour School shall follow the same course of instruction in both branches of the subject until they have reached a stage when they are competent to choose between them, and to specialise in one or the other. Less objection can be taken to Mr. Wyld's attack on " the conception of English philology which is expressed by the syllabuses of our universities at the present time." It is an indubitable fact that emphasis is usually laid on the wrong things, and that the curriculum imposed does not represent the progressive nature of the subject, which is too often presented as something lifeless. When so-called " historical grammar " deals mainly with problems of primitive Germanic philology, while New English phonology is almost entirely neglected ; when undergraduate students of English—not of Germanic—philology are expected to know the details of Gothic accidence and pre-Gothic sound-laws, while they treat the English language as if it had become ossified in the time of Chaucer, there is surely something wrong in our methods of presentment and our attitude towards the study. No true teacher or scholar but will agree with Mr. Wyld, that the right method is to get away as soon as possible from the atmosphere of textbooks and lecture notes, and to show the student " how and where the facts have been discovered, and make him understand why such and such inferences have been drawn from them." " Under the direction of his teacher the student will begin the work of research—the solution of simple problems, the searching out of facts not too hard of discovery—it matters not whether they have been discovered before or not ; the main thing is that the young student should carry out the operation for himself, and should thus put into practice the scientific methods in which he is being trained." " The first and last word in our aspirations for the future progress of our studies is Research. This is the life-blood of all learning."

Mr. Wyld's plea for the proper endowment of teaching libraries is one that will be endorsed by all whose lot lies in the new Universities. When the sum allowed annually for the purchase of English books and periodicals, both literary and philological, for the central University Library, varies in most of them between £20 and £40, without any provision at all for a class library, there is no possibility of giving that insight into the methods of research which is the first need if there is to be progress. It is generally realised that natural science must have at any rate the essentials of laboratory accommodation and outfit. Until philology and literature—not to mention the other Arts subjects—are given the same opportunities, that is to say, until there is access to the minimum of necessary books, humane learning will not and cannot flourish at the new universities, but will atrophy and die as the spirit of eager inquiry is replaced by belief in the formulæ of textbooks. Mr. Wyld does not speak too emphatically when he says that "the establishment and further development of these Teaching Libraries is not a mere luxury, desirable indeed, though of secondary importance, but a necessity of the first urgency at the present time, if the study of English philology in this country is ever to become a reality and to yield fruitful results."

Finally, since it is impossible to discuss all the interesting points made in this lecture, we would call attention to the extremely valuable suggestions about "fruitful lines of research which are open to the student of English Philology." As may be imagined by those who know his work, Professor Wyld does not consider the editing of texts as the first need. He urges rather the publication of a series of minute studies on the dialectical distribution of elements of vocabulary, and of well-marked dialect-features; the importance of place and personal name studies; and, above all, the primary necessity for the investigation of M.E. and N.E. sound changes, involving a minute study of documents from about 1400 onwards. Further, he points out the absence of any adequate inquiry into colloquial idiom from Chaucer's day to our own, and, allied with this, the question of the relation of literary and received standard spoken English to the various other forms of spoken English, regional and social. The field of research is large enough to provide work for all comers. It is the business of the universities so to reorganise English philological studies that the labourers may be ready for their task.

If Professor Wyld is able to work on the lines he has laid down in this inaugural lecture, then the University of Oxford should lead the way in the revival of philological studies in Great Britain.

EDITH J. MORLEY.

Symbiosis. A Socio-physiological Study of Evolution. By H. REINHEIMER. (Headley Bros., London, 1920.)

It is one of the easiest and the most unfortunate things in the world to allow oneself to be run away with by an idea. If we were to translate it into biological terms, a proceeding which I am sure would meet with the approval of our author, we should have to call it over-specialisation; and over-specialisation, as all we biologists know, lies perilously near to extinction. Mr. Reinheimer believes that he has found the secret of all evolutionary truth. Now, it is always dangerous to think that our own pet theory is going to explain the universe, or, indeed, any considerable portion of its workings. Of course it may do so, and then we are Newtons, or Kants, or Darwins, or Einsteins. But we are so much more likely to have got mounted on a Hippogriff of the worst disposition, which is running us off into the most outlandish places (though all the time we think that we are in perfect control!), that it behoves us to be very careful whenever one of our thoughts begins to move with that seductively exhilarating speed.

Mr. Reinheimer's Hippogriff is, it must be admitted, a glorious beast. From his back, Mr. Reinheimer believes that he can see the why and wherefore of biological progress and extinction, the time-map of life, spread in all clearness beneath him.

Briefly, his thesis is this: that co-operation between members of different species—in other words, symbiosis in the broadest sense—is the only mode of existence which makes for biological solvency and biological righteousness. He believes that you can draw up a system of Evolutionary Economics, and can see which modes of life result in an excess of expenditure over income, which lead to a growth of capital; nay, more, that an ethical flavour may be properly introduced into our evolutionary thinking, since only through symbiosis does life achieve its true destiny, which is progress.

Now, Mr. Reinheimer is right in a number of very important points. He has seen the wood that so many professional biologists fail to perceive for the trees—he has a clear idea of biological progress; and he has gone further than that, and stressed in a very original and suggestive manner the value of biological co-operation, of symbiotic modes of existence, for achieving such progress.

But, then, the Hippogriff has taken the bit in its teeth. In the end, our author cannot allow that anything but symbiosis is good, and tries to apply his thesis, like a quack medicine, to all things singularly and collectively.

Not content with his interesting suggestion that symbiosis is a contributory cause of progress, he insists that an opposed mode of life is definitely the cause of eventual decay and extinction. However much a carnivore may flourish for the time (and that whether it eat flesh or be a "plant-carnivore," i.e. a herbivore which devours without making its proper symbiotic "bio-economic" return), yet it is sowing within its constitution the seeds of its inevitable biological destruction. In some remarkable way, which is to be commended to the notice of bio-chemists, foods differ in their nutritive properties, and somehow affect the constitution of the species differently according as they are manufactured in the holy bonds of symbiosis or illegitimately and non-symbiotically. A quotation will give his point of view:

". . . they [the ductless glands] require to be supplied by the organism with raw material that avails to life in the fullest sense of the word. . . . And such 'tutored' food, increasing in adequacy with every higher degree of Symbiosis, and ideally equipped with potencies diffusable [*sic*] with great benefit and without injury over the co-evolved animal body, can only be obtained with the help of symbiotic vegetable partners. . . . We may take it that great irregularity of glandular action . . . is the norm amongst predaceous species, which as the result . . . are in the end left with diminished strength and endurance, and with uncouth, ill-shaped bodies" (as, for instance, a tiger?).

Frankly, this sort of thing won't wash; and it washes less and less the more we look into it.

He quotes Maeterlinck as an authority on seed-dispersal. Maeterlinck rejects the idea of natural selection altogether, and prefers to speak as follows: In seeds disseminated by birds "we see developed such a powerful reasoning faculty, such a remarkable understanding of final causes, that we hardly dare dwell upon it. . . ." To which our author adds: "This interpretation enables one to understand how the plant is able to communicate a share of its vital psychic equipment to the animal. . . . The animal takes in knowledge with its food, as it were—essential knowledge—which is 'predigested' by the plant." And so we are introduced to the stupendous idea of mind-vitamines, which interesting but hypothetical substances, in conjunction with Samuel Butler's mnemic theory of heredity, are to explain many remarkable facts—their lack, for instance, accounting for the sterility of hybrids (p. 105).

Later (p. 198) he introduces "the expression f/w $\left(\frac{\text{food}}{\text{work}}\right)$ as a way of representing a norm of behaviour *upon which almost everything in Biology depends*" (italics ours).

That is just it—Mr. Reinheimer wants to explain "almost everything in Biology" by means of his "bio-economic law." And almost-everything-in-Biology steadily refuses to lend itself to explanation by any single principle. It is too complex for that. Mr. Reinheimer never seems to have mastered the idea of Natural Selection properly, and recent work on Genetics is scarcely mentioned. He reads widely but uncritically; H. F. Osborn is quoted as an authority on one page, to be followed by Maeterlinck on the next; Lankester and Bergson, Samuel Butler and Metschnikoff all apparently vie with each other as supporters of his theory.

It is a thousand pities that Mr. Reinheimer did not take his central idea, the importance of co-operation for biological progress, and work it out soberly and sanely with reference to the ascertained facts of science. He would then have given us a valuable book. As it is, this idea is so overgrown with absurdities and irrelevancies that it is scarcely discernible. Until the author eliminates the fantastic and indeed meaningless talk about mind-vitamines, plant-carnivores, symbio-psychism, symbiotic restraint, mnemic heredity, the necessary degeneration of all carnivorous species, and so on and so forth, the book remains only a subject for melancholy ridicule.

Advance in science comes by laying brick upon brick, not by the sudden erection of fairy palaces.

J. S. Huxley.

Famous Chemists. The Men and their Work. By Sir William A. Tilden, F.R.S. (London: Routledge, 12*s*. 6*d*. net).

Sir William Tilden is well known as an informed writer on the history of experimental science, especially of his own subject—inorganic chemistry. In this book he has sketched in a simple and interesting way the lives of twenty-one of the most prominent chemists of the past. He has taken pains to make his readers interested in the lives of these men as they appeared to their friends and fellow-citizens as well as in the particular work in chemistry which they achieved. As the past has produced nearly as many famous chemists as are alive to-day, the author has wisely limited himself to a description of those who have taken part in the development of a great theory, and the theory he has chosen is the Atomic Theory, the joy and glory of modern chemistry.

It is a nice point whether the Greeks or the Hindus were the first to give us the beginnings of the atomic theory. The author, who doubtless hates controversy, has avoided this issue by commencing with the "father of chemistry," Robert Boyle, who lived in the seventeenth century. The evolution of the atomic theory since Boyle has depended on two things: the existence of the crude theory prior to Dalton's (or Higgins') great work, and the development of our knowledge concerning gases. Of pioneers in these fields the author describes Black, Priestley, Cavendish, Scheele, and Lavoisier. He then reaches Dalton, but oddly enough makes no mention of Dalton's rival, William Higgins. Higgins was a failure, Dalton a success. Higgins, moreover, was an objectionable fellow, Dalton a Christian and a gentleman. But it seems now established that Higgins reached essentially the same conclusions as Dalton, and published them fourteen years earlier. He cannot be ignored.

Of the chemists of Dalton's day the author has written of Gay-Lussac, Proust, Berzelius, Davy, and Faraday. These bring us well into the nineteenth century, when the theory went rapidly from strength to strength. Here the author confesses his difficulty in choosing whom to include and whom to leave out. Liebig, the extract-of-meat-merchant, is included more, I think, because Sir William had an accurate and interesting biography of him ready than for any great connection he might have had with the atomic theory. Ramsay, too, might well have been omitted, for although he was a great man and great chemist, his contribution to atomic theory, his work on radio-activity, was at times surprisingly ill-informed and poor. Avogadro, Cannizzaro, Dumas, Frankland, and Williamson are rightly included. In the section on the classification of the elements the author has included Mendeleeff and Crookes, but has given merely a passing mention to Lothar Meyer and Newlands. The German and the Englishman are not so well known as the lion-headed Russian, yet their scientific work is not less important.

These little criticisms are not meant too seriously. The author has a perfect right to choose his men so that their biographies may be made of interest to the general reader. Those he has done are well done. They are accurate and they are interesting. In avoiding dullness he has not allowed himself to fall into a forced breeziness, and he is never slipshod. The book is cordially recommended to readers. Students of chemistry will find it of most value if they use it in conjunction with a technical history of scientific theories, such as Lowry's admirable *Historical Introduction to Chemistry*, published by Macmillan.

A. S. R.

DISCOVERY

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Editorial Notes

On the recommendation of the Managing Committee, Mr. Murray has appointed to the vacant editorship of Discovery Mr. Edward Liveing, B.A., the author of *Attack* (a description of his experience as an infantry officer in the Battle of the Somme) and well known for his contributions to fiction and poetry in the current periodicals of the day. The Committee hope with confidence that, with the continued co-operation of Dr. Russell as Scientific Adviser, the new appointment will mark a new stage in the prosperity and popularity of Discovery.

* * * * *

At the present moment in the intellectual world everybody is working very hard, and, if appearances at close range are not deceptive, working to good purpose. People who are feeling depressed after the Great War may possibly be doing so because they are meditating upon the wrong things, for it is not difficult to suggest topics the consideration of which will imbue the thinker with optimism and hope. The war has had a bracing effect in general upon the intellectual world. The period 1914–1919 has been like the long and somnolent vacation which precedes the October-to-Christmas term at schools and universities—a time when work is pleasant, and energy and enthusiasm are displayed to the full.

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This fact is reflected not only in the large and important contribution which both science and the humane studies are now making to learning, but in the deepening interest which the general public are taking in knowledge of all kinds. Take the present interest in Einstein as an example. Ninety-nine people out of a hundred do not know what Einstein is getting at, but most of them realise one thing, namely, that Einstein has wakened everybody up. He has amazed the physicists and astonished the philosophers. There is not " any money " to be made out of his scientific work, but he has shown us again what science has always been showing to those who will look—that it is really a wonderful world we are living in, and that it is going to appear to us more and more wonderful as the years roll on.

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There is one great difference between to-day and, say, thirty years ago: we are more fully conscious that we are on the eve of big discoveries now than men were then. It is said that in the early nineties students of physics thought they had progressed so far with discoveries in that subject that there seemed little or nothing further for the future to do. Of course everything could be developed, constants might be more accurately determined, instruments made more sensitive. But in the main so-and-so's hypotheses were universally applicable, and so-and-so's equations could be adapted to suit all emergencies. It was very nice that things had approached so wonderfully near to finality, that, so to speak, the universe was " taped."

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And then a few years later (I am speaking of physics only), Röntgen discovered the X-rays, Becquerel discovered radioactivity, and Madame Curie radium. Rutherford showed that nature was continually doing herself what the alchemists for centuries had failed to do—to bring about transmutation of elements. Marconi telegraphed without wires. The men who humbly and [illegible] thought they had the universe " taped " had to confess their mistake when the feeble opposition which some of them put up to the new theories had been completely demolished by experimental facts. One thing is very certain now, and that is, that in thirty years the people living then will look upon us as blind as bats for failing to discover the host of obvious things which to them will be commonplace.

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Progress and development in science have been very much in my mind through reading recently several books on the history of that subject. In particular one book, published by the Cambridge Press, has interested me very much, *The Scientific Papers of the Hon. Henry Cavendish, F.R.S.*[1] This is really a magnificent work. Every lover of science must be grateful to the editors of these two volumes for their labour of love, and to the publishers for their courage and enterprise in publishing this complete edition of the scientific writings of Cavendish.

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These two volumes are the final garnering of the work of one of the greatest of discoverers. They contain the whole of Cavendish's previously published work and all the important work that has hitherto remained unpublished. The first volume appeared in a different form in 1879. It was then edited by Professor Clerk Maxwell. In 1874 Cavendish's papers preserved by his kinsman, the Duke of Devonshire—a very remarkable and even mysterious record of progress in electrical as well as in chemical science—were put into Clerk Maxwell's hands, and the editing of the MSS. was his chief continuous literary occupation until his death five years later. The result was *The Electrical Researches*, of which it has been said " there is no instance in the history of science in which the unpublished records left by an investigator have been arranged and elucidated with such minute fidelity." The first volume is a new edition of this one. It has been carefully revised and annotated by Sir Joseph Larmor. It contains as an appendix Dr. Thomas Young's life of Cavendish, printed originally in the *Encyclopædia Britannica*, and as frontispiece a reproduction of the only portrait of Cavendish extant, a water-colour sketch preserved in the British Museum.

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The second volume is quite new. It deals with the chemical and dynamical work. Sir Edward Thorpe, who edits it, has gone carefully through the unpublished papers dealing with researches in chemistry, and has welded the mass into a most interesting whole. He contributes a most valuable introduction. On special points he has had the assistance of four of his colleagues in the Royal Society.

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Henry Cavendish (1731–1810) was a remarkable man. There was nothing Byronic about him. He differed so greatly from the conventional eighteenth-century type that a superficial observer might almost consider him eccentric. He did not quite manage to sell all that he had and give it to science. He gave himself, which was a great deal, and the rest that he had accumulated at the bank—accumulated there for other people. For a man whose grandfathers were dukes he lived a very simple and unostentatious life, being no more lavish in his expenditure than the man whom Mr. Punch conceives to be the canny Scot. Yet when he died he left a million and a half. He was undoubtedly one of the originals of a once popular conception of a scientist, the eccentric who can explain the universe, but is not quite sure of the change of a shilling. He had shy, conservative, and unconventional habits. He had a hatred of women, of talking, of any town except London, of any meat except mutton. His voice on the rare occasions when he used it was squeaky, and his manner embarrassed. A contemporary writer says of him that " he had a peevish impatience of the inconveniences of eminence." His dress was about fifty years out of fashion—a three-cornered cocked hat, a high coat collar, frilled shirt-wrists, and a faded violet suit.

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In reading a biography one is perhaps too apt to remember a man's eccentricities. There is another side. Cavendish was a thoroughly good scientist. In all his scientific work and relations he was perfectly normal. He was a prominent member of the Royal Society, attended its meetings regularly, talked there, dined with fellow-members after the meetings, and published all he did publish in the Royal Society's Transactions. Indeed, one may say that but for his eccentricities Cavendish would have frittered away his life as an eighteenth-century buck. Instead of that Cavendish was—well, he was Cavendish.

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Cavendish indeed was a magnificent experimenter. There is an old taunt sometimes flung against the modern physicist in his beautiful laboratory with its expensive apparatus, " He cannot see the truth for the brass." Brass and lacquer did not stand in Cavendish's light. For one thing, in his day all apparatus was crude and primitive ; for another, Cavendish's bent was towards the simplicity and informality of design that is now associated with the drawings of Mr. Heath Robinson.

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[1] *The Scientific Papers of the Hon. Henry Cavendish, F.R.S.*, two volumes. Vol. I : *The Electrical Researches*, edited by James Clerk Maxwell, F.R.S. Revised by Sir Joseph Larmor, F.R.S., M.P. Vol. II : *Chemical and Dynamical*, edited by Sir Edward Thorpe, F.R.S. (Cambridge University Press, 12s. net.)

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His interest in science, and especially his desire to measure things, were almost pathological. He had remarkable insight which led him often to foretell what was going to happen in an experiment, or to guess approximately the magnitude of some effect he was about to measure. He was a great man at trying to do everything exactly. One of his greatest discoveries was that of the composition of water. His determination of the mean density of the earth (which Sir Isaac Newton had guessed at between 5 and 6) was less than 2 per cent. smaller than the most accurate result of to-day (5·53). He found that there was 20·83 per cent. by volume of oxygen in the air, and the best estimate at the present time is 20·96. In working experimentally on the capacity of a charged sphere he determined a certain ratio to be 1·57. Years afterwards Lord Kelvin proved that this ratio theoretically must be the half of π. And the half of π is 1·571. Often he was so anxious to press forward with new experiments that he did not trouble himself to publish a record of those he had finished. As these books abundantly prove, Cavendish had anticipated discoveries which, because he kept a record of them in his notebook instead of publishing them, are now attributed to the later workers who rediscovered them. Thus he prepared several chemical compounds, such as arsenic acid, which are attributed to Scheele, and forty-six years before Ohm published his work he discovered the important law in electricity which goes by the latter's name.

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Cavendish paid great attention to electrical resistance —especially to the resistances of solutions. One of the things that puzzled Clerk Maxwell when he went through Cavendish's papers was how the latter was able to measure this. For one cannot measure electrical resistance even at the present day without some kind of a galvanometer, and the galvanometer had not been invented in Cavendish's day. The explanation is simple. Cavendish was his own galvanometer. By passing the electric current through his own body he estimated its intensity to a nicety by the shock he sustained, and in this way he sized up resistances wonderfully well.

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It is sometimes argued that a study of the past of any science is a waste of time, since it is difficult enough in all conscience to follow it in its many ramifications to-day without saddling oneself with a study of how the facts grew into being. There is much truth in this view, but an occasional dip into the past may and often does encourage many a man to set to and do as the pioneers have done. It is the same Cambridge which gives from time to time to the world the occasional writings of her great men of science, of which these volumes on Cavendish are an example, which is to-day the most considerable centre of discoveries in pure science in the world.

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In the long list of great men whom Cambridge has given to the world Cavendish has an honoured place. No one wants to affirm he was her greatest son. But he was a great man, a natural philosopher of the broadest possible type, who occupied himself in turn with every branch of physical science known in his time. On each he impressed the marks of his genius and the extraordinary penetrative force of his intellect.

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The recent death of Dr. W. Warde Fowler has removed one who held a position almost unique in our own day in its felicitous union of the naturalist and the scholar. It seems almost incredible that the man whose ripe scholarship made him the recognised authority on the social evolution and the religion of Rome could also find leisure to write the only record of English rural life, in *Kingham, Old and New*, fit to rank with the immortal *Natural History of Selborne*.

* * * * *

His latest volume, a collection of some of his papers under the title *Roman Essays and Interpretations*, which we hope to notice more fully next month, contains much characteristic work. For instance, he deals with the habit, common to many Indo-European races, of associating the oak with Jupiter, the thunder-god. He shows that the sanctity of the oak is probably connected with the strange fact that this tree is more often struck by lightning than any other. If the frequency with which beech trees are struck be represented as unity, the figure for oaks is sixty. The human interest, the scholarly criticism, and the sincere love of nature which these papers show are typical of his many-sided personality. Dr. Warde Fowler will be regretted by a far wider circle than his own University of Oxford.

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Elsewhere in this issue is printed a letter from Sir Arthur Conan Doyle bearing on my editorial remarks of last month. The question at issue is the existence of fairies. It may be said here that an argument on an important subject like this one cannot be conducted adequately in the pages of a popular magazine. It is a problem for a learned society—for authority, not private judgment. Only in such a society can a fair, an unprejudiced, and an impersonal opinion on the matter be arrived at.

Maxim Gorki

By M. V. Trofimov, M.A.

Professor of Russian in the University of Manchester

Of contemporary Russian writers, Maxim Gorki is the most representative of the spirit and tendencies of his age. He has concentrated the despair and the hope of Russia, the sense of social wrongs and evils, the horror of moral decline and the passion for regeneration, the shadows and lights of the human soul. In the penetration and vigour of his methods of analysis and description, no other Russian writer of the present time equals him.

Gorki's personality excited keen interest. His stories at once seized on the imagination by their refreshing breath of life and force of style. The general mood both in the life and literature of the time was distinctly "Chehovian." The country was enveloped in the twilight of political reaction, and the educated classes moved indifferent and aimless in the atmosphere of gloom and depression. Gorki struck a new note. He brought to the stage a new hero who scorned all intellectual conventions and challenged all established traditions. In contrast to Chehov's dim, grey, and immovable pictures of Russian life, Gorki's stories fascinated the reader by flashes of boisterous spirit, pulsations of human energy, outbursts of strong passions, and yearnings for a new ideal. The spirit of fire and revolt in Gorki's stories was a welcome contrast to Chehov's hopeless pessimism.

In the face of the most adverse circumstances—for he was born in a mean and poor family—Gorki has hammered out for himself a path into literature as the champion of the downtrodden and outcast. The social *milieu* which produced him and sent him forward with a message was the town democracy roused to the realisation of its own rights and aspirations. He broke the eminently rural character of Russian literature by portraying types, ideas, and emotions brought forth by the development of town civilisation. But before making workmen and tramps his chosen heroes, Gorki touched on some themes previously known in Russian literature, and in these he struck a romantic chord. His imaginative tales and legends resounded with a note of passion for the life full of vigorous emotions, unbending strength, beauty, and glory. This belief in the spaciousness, luxury, and potency of life made Gorki feel dissatisfied with the existing conditions, and led him to the idealisation of tramps and vagabonds. He represents the ragged, hungry, and shelterless vagabonds as refugees from modern civilisation which they denounce for its falseness, its suppression of natural instincts, and its trampling upon the weak and the poor. Gorki's great gift for pungent criticism and his extraordinary capacity for scorn shine throughout the vivid and biting speeches of his heroes.

Under the shabby exterior of the tramps, Gorki traced passion for freedom, love for nature, unselfishness, hatred of shams, and a great capacity for joy.

Some of Gorki's heroes are philosophic *nihilists* who have broken away from the community with the object of asserting their own freedom and becoming masters and creators of their own lives. One feels that the views and ideals they profess are those of the writer himself, who strained his imagination and violated psychological truth by dressing his idlers, thieves, and drunkards in the romantic garb of crusaders of the new humanity. Gorki assumed the attitude of the realist when he came to describe the tramps as social types, without entrusting them with a special message. Ugly and sordid is the life of the paupers and outcasts he then portrayed. Under the present order of things, they are obnoxious social refuse, worthless chaff of humanity. Like the dust raised and carried away by the wind, the wretched crowd of Gorki's outcasts are wandering through Russia's expanse, leaving everywhere traces of their sad and miserable existence. At times, the gloom of the stories is dispelled by bracing descriptions of nature, or by the rays of warm poetic feeling proceeding from the author's faith in the potent beauty of life. But with all the passion for freedom beating strongly in their hearts, the tramps are incapable of making any efforts at constructing a new life. The desire for the expression of individuality finds vent with them in drunken speeches and brawls and in criminal adventures.

When Gorki realised the inefficacy of his vagabonds, he turned his hopes towards the industrial workers. The place of action was now transported to workshops and factory quarters. He viewed the labour movement through the prism of the Marxian doctrine, coloured with his own enthusiasm for the ideals of Socialism. The worker appealed to Gorki's imagination as a man with a heart elevated by unselfish feelings, with energy and resolution, with blood rich both in phosphorus and in iron. The working class as a whole rose before his eyes as an army of labour animated by the passion for the emancipation of man. In this spirit he wrote the novel *Mother*, describing the conditions and mentality of the factory workmen. Here Gorki traced the intellectual growth of a young workman and his conversion to a new political and social faith. The general atmosphere, as well as the minute features and incidents in the life of the workman's community, are depicted with knowledge, skill, and sympathy, and the author showed his profound sense of character in painting the portrait of the peasant mother who died for the workers' cause. In his stories, written under the fresh influence of the social-democratic ideas, Gorki idealised the factory workers by attributing to them a certain spaciousness and integrity of outlook, courage in thought and action, love for humanity, and faith in the triumph of their ideal. He lifted his working heroes above the general level, as he had previously done with his tramps. But the time came when the sense of life made him change his attitude towards his former gods. He threw off his romantic clothing and came face to face with the bare facts of everyday life. Freed of his doctrinaire creed, Gorki realised at once those depths of ignorance, poverty, humiliation, brutishness, and stupidity which form the daily life of the grey Russian masses. Continually, in the stories of Russian rural and urban life, he draws grim pictures of degradation. Describing "some incidents in the life of town Okurov," Gorki extends the sphere of his observations to the general inquiry of " What is Russia, and why is the life of the people so hard, and why are all so unhappy and convulsive, so immovable, as if they were turned into stones ? " Gorki speaks of a general decline of character prevailing in all classes of the community, and one of his men remarks that the little town Okurov, which is so deeply sunk in the morass of its stupid and uncivilised life, is only a small part of " that blissful country which has everything in abundance and lacks one thing only—common sense." The author's spokesmen are deploring the " double-naturedness of man, his moral pliancy and slavishness, his lack of faith and creative ideas," etc. Gorki feels sad at the sight of this tragic picture, but he does not become bitter or pessimistic.

ANTON CHEKOV
(By kind permission of Messrs. Chatto and Windus.)

There is a note of optimism and enthusiasm in the words he assigned to Kozhemiakin, who says: " New workers in the field of life have arrived; their hearts are filled with love for the earth soiled by us; they will plough up the field of God laying bare its heart, and it will shine like a new bright sun for all of us, and everybody will feel warm and happy."

No social class in Russia escaped the crushing and fatal curse of the cultural backwardness of the country. In the story *Three Days*, Gorki shows us the depths of utter misery into which the blind force of ignorance, prejudice, and drudgery has driven the peasants. Through the dim windows of wretched cottages are looking at us the ailing, suffering, and sadly obedient faces of those doomed to be ever submerged in darkness and sorrow. The story called *The Fire*, dealing with the artisan class, presents the same picture of unhappy and disorderly life, void of all sense and goodness. The minds and hearts of the industrial workers seem also to be depressed and demoralised by the cruelty, slavishness, greed, and cynicism of everyday existence. But moving in the dark shadows of dismal reality, Gorki remains ever radiant with his belief in a brighter future. He feels within himself the moving of fresh life, and there are many characters in his novels and plays who reflect the author's optimistic mood. In the story *Three Days*, the village schoolmaster, Pokrovski, gives forth this message: "Men of sincere and generous hearts are daily entering life in hundreds of thousands of villages, and some day Russia will see itself intelligent and honest. Only do not forget that God's spark shines in every human soul, and one should try and blow this spark of life into a great flame." Gorki has never lost his faith in the goodness of human nature. He sees that the ugliness and misery of life is only like a layer of dirt on the free human soul. His heroes, bruised, shaken, and disgraced as some of them are, preserve certain internal qualities which excite sympathy in the reader's heart. A hereditary and professional thief, Vasili Pepel, in the drama *The Lower Depths*, is at the same time a dreamy, sensitive, and pure man.

The source of Gorki's inspiration is his belief in the new man, who is to be free and strong and beautiful. He is thrilled by the thought of the infinite capacity of human nature. Some of his poems and sketches are exultant hymns to the glory of "tragically beautiful Man."

"Man!" exclaims Gorki. "I see his proud head and his daring deep eyes, and in them—rays of fearless, powerful thought, thought that understood the wonderful harmony of the universe, thought which in the moments of tiredness creates gods, and in the periods of activity—pulls them down."

"Possessing only the power of Thought, which is sometimes like lightning, and sometimes cold and quiet like a sword, the free and proud man walks far in front of men, towering above life."

But Gorki has created no superman. His belief in human possibility is based on his study and knowledge of ordinary man, whose divine soul calls him to live upward, "towards the vastness."

"The new man wants," he explains, "to create a new order based on the unshakable principles of freedom, beauty, and respect for men." This ideal can only be realised in the order of life free from inequality, privileges, masters and men. Gorki foresees in some distant future a reconstructed social order within which collectivism and individualism will not be "antinomies," but will form a living union and bring about a unification of the instincts with the idealistic will. Such is the present stage in the evolution of Gorki's ideas. He has arrived at worshipping collectivism and its creative power. From this it is clear why he supports Lenin in his wild experiment in changing the individualist peasant Russia into a communistic proletarian Russia. Gorki came with a "song glorifying the madness of the brave," and he thinks Lenin to be "perhaps the greatest of all madmen," but he pleads that Russia should be left alone to her madness or wisdom. "Two men are fighting on the earth against each other: the Red man and the Black man," he says in one of his tales published in June last year. "The strength of the Black man is in his insatiable thirst for power over men. The strength of the Red man is in his passionate desire to see that life is sensible and bright." And Gorki remains true to his original faith.

WORKS OF GORKI TRANSLATED INTO ENGLISH

Heartache and the Old Woman Izergil. (Maclaren & Co.)
Creatures that once were Men. Introduction by Chesterton. (Alston Rivers.)
The Outcasts and Other Stories. (Fisher Unwin.)
The Orloff Couple and Malva. (William Heinemann.)
Three of Them. (Fisher Unwin.)
Twenty-six Men and a Girl. (Greenback Library.)
Tale of Two Countries. (Werner Laurie.)
Foma Gordyeef. (Fisher Unwin.)
My Childhood. (Werner Laurie.)
In the World. (Werner Laurie.)

The Rhine Boundary and Talleyrand, 1814–15

By R. B. Mowat, M.A.

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THE only Peace Conference which can be compared in importance with that of 1919 is the Congress of Vienna, in 1814–15. The organisers of the Conference of Paris had constantly in their minds the precedents of 1814, and consciously worked to avoid the pitfalls into which, as it seemed, the diplomatists at Vienna had sometimes fallen.

Perhaps the greatest difference between the Conference of Paris and the Congress of Vienna was that at Vienna, France, against whom the Great War had been fought, was ultimately admitted as a full member of the Congress, and took part in the negotiations which led to the drafting of the various treaties of peace, including the Final Act; but at Paris, Germany was not a member of the Conference, and was presented only with the final project of the Treaty, and allowed to make written comments on it.

It is true that there was one obvious difference between the position of France *vis-à-vis* the Allies in 1814 and the position of Germany in 1919; when the Congress of Vienna opened, peace had already been made between France and the Allies (Treaty of Paris, May 30, 1814); but when the Conference of Paris opened, Germany, having only made an armistice, was still in a state of war with the Allies. Nevertheless, although France in the autumn of 1814 was technically at peace with the Allies, the Allies had no intention of admitting her as a member of the Congress, to take part in their deliberations. For over three months Talleyrand was at Vienna, and never was admitted to a session of all the four allied powers (Great Britain, Austria, Russia, and Prussia). It was not till January 9, 1815, that the Council of Four became, through the inclusion of France, the Council of Five. It is worth considering, therefore, how Talleyrand brought this about, and whether the usually received view (which is his own view) about his policy is correct.

Talleyrand's own account is given in his memoirs, and in his letters to Louis XVIII is very flattering to himself. He arrived at Vienna on September 23, 1814, and found that France was isolated. It soon became clear that there was going to be no Congress in the usually accepted meaning of the word; that the many sovereigns and governments assembled at Vienna were not going to be consulted; that the French were likely to be left completely on one side; and that the four great Allies—Great Britain, Austria, Russia, and Prussia—were going, in the persons of their plenipotentiaries, to settle things entirely by themselves. Gradually, however, a rift appeared in the grand alliance. Russia and Prussia on the one hand, and Great Britain and Austria on the other, were found to have divergent interests. Alexander of Russia meant to annex the Duchy of Warsaw (which Napoleon had created out of the former Poland); and Frederick William III of Prussia meant to annex the whole of Royal Saxony, whose king, Frederick Augustus I, had been the last faithful ally of Napoleon. Frederick Augustus had been taken prisoner at Leipsic, and his whole kingdom had been conquered, and was now occupied by Prussian troops. On the other hand, Austria was all against Prussia being aggrandised by the annexation of Saxony, and was not too friendly (nor was Great Britain) to the Russian design of annexing the Duchy of Warsaw.

This divergence of interest between Prussia and Russia on the one hand, and Great Britain and Austria on the other, became so acute that the great Allies at Vienna practically divided themselves into two camps; and open war between them was threatened. In such a situation, France had obviously the opportunity to hold the balance; she had still a powerful army, which might turn the scale if thrown vigorously on one side. Talleyrand was just the man to use this opportunity, and so well did he do so that, after receiving various offers from both sides, he finally accepted a military alliance with Great Britain and Austria. On January 3, 1815, Castlereagh and Metternich signed a secret treaty with their former enemy, engaging each one of the three to defend each other, and to put 150,000 men in the field if any threat of attack were made against them. Thus France gained admittance to the councils of two of the chief Allies at the Congress of Vienna. Furthermore, she was admitted to the formal meetings of all four Allies on January 9. Henceforth there was no longer a Council of Four, but a Council of Five. The solid front shown by Great Britain, Austria, and France induced Prussia and Russia to give up a good portion of their pretensions in the Saxo-Polish question. In particular, the King of Saxony was left on his throne at Dresden, with about half his former territory, Prussia having to content herself with annexing only the other half.

Talleyrand takes great credit to himself for thus raising France, so soon after her defeats in the war, to be one of the five controlling powers of Europe. And he writes triumphantly, and quite truthfully, to Louis XVIII at Paris that the anti-French coalition no longer exists: " Maintenant, Sire, la coalition est dissoute, et elle l'est pour toujours " (*Correspondance Inédite*, p. 209).

The disruption of the anti-French coalition, and the admission of France to the Concert of Europe—these are the gains of Talleyrand at the Congress of Vienna. But how did France pay for these gains? She appears to have paid for them by giving up her territorial security, and by putting herself in a position which, in the long-run, made it inevitable for her to fight the wars of 1870 and of 1914.

The reason for making this statement is as follows: On December 29, 1814, while Prussia was still bent on annexing the whole of Saxony, Hardenberg, the chief Prussian delegate, sent to Metternich a specific offer to indemnify the King of Saxony for the loss of his kingdom by setting him up in a new kingdom on the left bank of the Rhine. This new kingdom was to consist of the Duchy of Luxembourg, a part of the Archbishopric of Trèves (including the city of Trèves itself), and the southern portion of the Archbishopric of Cologne, including the town of Bonn, and the Abbeys of Prüm, Stavelot, and Malmédy. The territory thus to be assigned had a population of 700,000 (D'Angeberg, p. 1863).

The same project (which appears really to have been due to the Tsar) was put before the Council of Four in the form of a draft treaty on December 30 (ibid., p. 1869).

Metternich and Castlereagh rejected this proposal, for very obvious reasons—Metternich, because the annexation of Saxony by Prussia would destroy Austrian preponderance in Germany; Castlereagh, because the British Government did not wish to see a client state of France (which was still felt to be a danger to Europe) established so near to the Low Countries and the mouth of the Rhine (Castlereagh to Lord Liverpool, January 5, 1815, in Wellington, *Supplementary Dispatches*, ix. 528). Talleyrand also rejected the proposal when it was communicated to him, and instead he accepted the offer of Castlereagh and Metternich of a military alliance with Great Britain.

That the project of setting up the King of Saxony on the left bank of the Rhine was communicated to Talleyrand, he himself acknowledges. He describes the project in a letter of January 3, 1815, to King Louis XVIII. In another letter, of January 6, to the King, he says that the Tsar has sent Pozzo di Borgo to Paris to gain Louis' consent to the project; and he goes on to state his objections to it, viz. (1) that it is against the principle of legitimacy; (2) that it would change the relative strength of Austria and Prussia. To Castlereagh Talleyrand expressed himself "with great propriety"; ambition and the idea of conquest inclined him to accept the Tsar's project, but he desired to put a restraint on any extension of the existing boundaries of France (Castlereagh to Lord Liverpool, January 5, 1815, in Wellington, *Supplementary Dispatches*, ix. 528).

To suppose that Talleyrand really had these scruples is mere nonsense. His whole career proves the contrary. The truth is clearly that he preferred to accept the offer of the Anglo-Austrian Alliance, and thus to get France, lately so defeated, into the position of one of the arbiters of Europe. But at what a price! For if he had accepted the Prusso-Russian offer; if the King of Saxony had been established in a buffer state on the left bank of the Rhine, Prussia would never have been the danger she became on the north-eastern frontier of France. *The Prussian and French frontiers would not have touched each other.* It was because Prussia was forced to give up her claim to the whole of Saxony that she was indemnified by being allotted territory on the left bank of the Rhine. As the most recent historian of France says: "It seemed that France had gained a great success. However . . . it had been necessary to sacrifice the tranquillity of the French frontier" (Charléty, p. 40).

It only remains to ask whether Talleyrand could have accepted the Prusso-Russian project, in spite of the opposition of Great Britain and Austria. Castlereagh was determined to employ all the military strength of Britain to defeat the proposal, but it is very doubtful if he could have prevented it. For Prussia and Russia had extremely powerful armies, and France was by no means helpless. In a war to safeguard the left bank of the Rhine, recruits would have flocked to the standard as readily as they came to Napoleon's when he returned from Elba two months later. "The line of the Rhine, Belgium, Luxembourg alone, would make recruits abound" (*Jaucourt to Talleyrand* in Charléty, op. cit., p. 41).

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The Daylight Micro-Projector

An Optical Apparatus, invented by a French Physicist, which dispenses with the use of Lantern Slides and is of invaluable use to Lecturers and Others

By G. Frederic Lees

One of the most recent meetings of the French Academy of Sciences was noteworthy on account of a communication made by M. Branly on the subject of a remarkable optical apparatus, invented and recently perfected by M. Dussaud, which is calculated to render invaluable assistance to lecturers and others who, for the purpose of supporting their remarks by means of documentary evidence, require to throw on the screen photographic or other illustrations. The ordinary magic lantern used at lectures and other demonstrations requires darkness and specially prepared lantern slides, but the "dussaud," as the inventor has elected to call his apparatus, is operated in the full light of day, and is so constructed that any object of a size that can be introduced into the apparatus can be projected on to the screen or anywhere in the room where the demonstration is taking place. This enables the members of the audience to take notes and saves the great cost of making lantern slides.

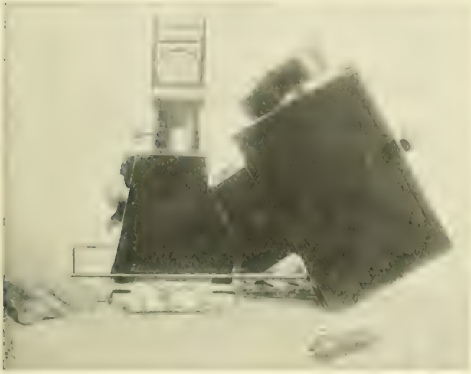

Fig. 1.

Before giving a detailed description of the photographs which illustrate this article and the various uses to which the "dussaud" can be put, let me state the principles upon which the lantern is based, in accordance with the official communication made to the Academy of Sciences.

The maximum of luminous efficiency has been obtained by means of condensers with one or several lenses, the focus of which has been calculated by M. Dussaud in relation with that of the reflectors at the back of the source of light, and in such a manner as to make it as short as possible—in certain cases not more than 5 centimetres. In this way the whole of the light is concentrated by reflection on the object to be lit up and projected. M. Dussaud claims—and the demonstration before Parisian scientists proves his contention—that his optical systems realise the conditions of precision and yield of microscopes, and constitute, in fact, collective microscopes. With half-watt electric lamps, only 3 amperes from a voltage of 110 volts (the minimum quantity of voltage supplied by Parisian electric-light companies) suffice to project objects with their form, colour, relief, and movements, the dimensions of the projection being as large, if necessary, as 9 square yards either on a screen or on any vertical, horizontal, or oblique surface. The apparatus is very easy to use, and its small size and weight enable it to be held in the hands in all positions. For home use it is admirable, since it can be connected with the electric-light current by means of any ordinary plug. The apparatus is cooled by circulation of air around the lamp, the optical system, and the object to be projected, the temperature not rising above 25° Centigrade (77° Fahrenheit) after the apparatus has been in use for a quarter of an hour. The object to be projected is placed at the base of the apparatus, which thus forms a sort of laboratory table fully lit up and the dimensions of which, according to the type of apparatus used, are 6 cm. by 6 cm., 12 cm. by 12 cm., or 24 cm. by 24 cm.

M. Dussaud has devoted seven years to the solution of the problems which this apparatus set him. He was, indeed, faced by a triple problem: a mathematical one through the calculation of the curves, a chemical one through the composition of the matter used, and a physical one through the calculation of the indices of refraction, "because he considered that such an optical system, enabling one to see objects enlarged up to 125,000 times *in volume*, in a fully lighted room, would render the greatest service to science."

We will now examine, in the light of the illustrations, the various uses to which the "dussaud" can be put.

Fig. 1 represents its use with two cylinders, on which is unrolled and rolled a spool of paper bearing illustrations or a text which have to be projected. The lamp and its reflector is in the box on the right, and the light is thrown on to the images as they are unrolled by the hand of the lecturer. Above them is a combination of lenses which throws the pictures on to a mirror which swings on an axis, and it is this mirror which projects the illustrations on to the screen or wall or ceiling, according to the angle at which the mirror is set. It is because of this ingenious arrangement that projection

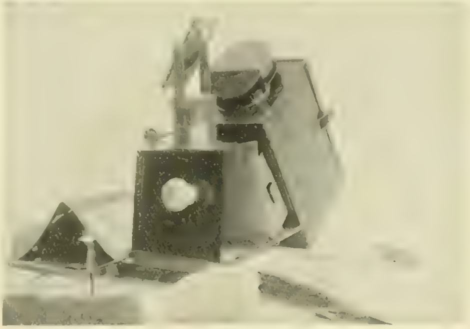

Fig. 2.

is possible in a fully lighted room; there is no luminous cone, as in the case of an ordinary projection lantern worked in a darkened hall; and when the projection is made on a suitable screen and the images shown are pictures from Art Galleries, they have all the appearance of being the works of art themselves.

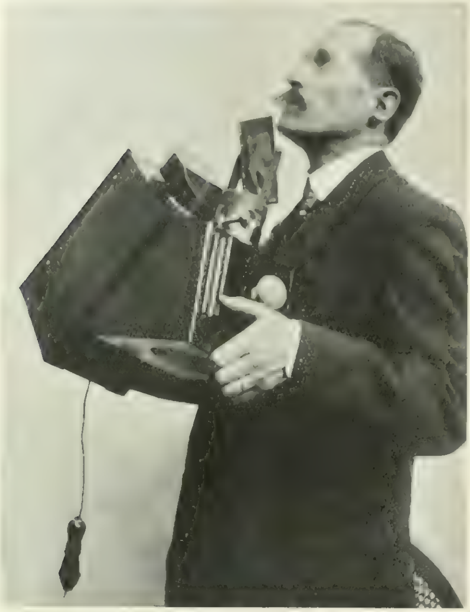

Fig. 3.

Fig. 2 shows the apparatus when used with a folding album in which picture postcards, reproductions of paintings, etc., have been pasted or otherwise fixed. As in the previous instance, the correct focussing on to the screen is done by means of the rack and pinion with which the lenses are provided. It will be seen that the space underneath the portion of the lantern which is lit up is sufficiently great to allow an open book to be slipped under. This is of the greatest utility to lecturers, who so often need to support their remarks by reference to an illustration or a diagram in a work of authority—an illustration or diagram which, in the case of an ordinary projection lantern, would necessitate the making of a lantern slide. The multitudinous uses to which the " dussaud " lends itself in this connection will occur to the reader. I need mention but two or three, such as scientific gatherings, lectures before military students, board meetings, demonstrations in clinics, etc.

To project an object, say a necklace of beads, it is introduced into the apparatus through the door. To protect the eyes of the lecturer from the intense light which pours on to the object when this is done, a mobile screen with a piece of dark-coloured glass in the centre is hooked on to the top of the box, so that no light escapes. This enables the demonstrator to see what he is doing. It is when the apparatus is in this form that it renders the utmost service to the lecturer on natural history, the engineer, or commercial traveller. Natural history specimens can be introduced with the greatest ease and enlarged to a size which shows their anatomy, movements, colour, habits, etc., in an altogether astonishing manner. Collectors of engravings, numismatists, philatelists, jewellers, and, above all, financiers will find M. Dussaud's invention of particular value in this form. I may add that it was recently used at a great Parisian bank for the projection of bank-notes and cheques, some of which were believed to be forgeries, and the spurious notes or altered cheques were, thanks to projection, detected with the greatest ease in the presence of a number of experts.

Fig. 3 shows the inventor holding his apparatus and projecting a sketch wherever he likes: on to the ceiling, on to a wall, or above a doorway. It is when the apparatus is used in this manner that it will be found of the greatest use to architects or artists who wish to judge of the effect of a given piece of decoration, say, in the corner of a room just underneath the ceiling. And the effect can be judged, with all the colours of the little sketch which is being projected shown, under natural conditions of lighting, that is to say, in the full light of day. Architects need no longer resort to the stencilling of their designs, to the squaring off of their drawings, to the camera lucida, to the pantograph, or to other mechanical means of enlarging their sketches. All that one has got to do is to project the design on to the spot chosen, and then sketch it in.

Fig. 4 represents (from left to right) the four elements of which the " dussaud " is composed. On the left is the box containing the lens and bearing at the top

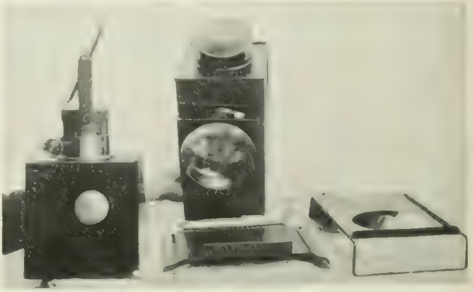

Fig. 4.

the mobile mirror. In the middle at the back is the box containing the luminous source—a box which fits on to the preceding one. In front of it is the support for the passing of illustrations, etc., under the shaft of light, with its two rollers. And on the right is the support for the apparatus when it is necessary to raise it from the table to a sufficient height to enable a book to be slipped underneath.

These four elements may be put together and arranged in different ways for particular purposes.

For example, the elements of the "dussaud" may be combined in such a manner as to project any object or any action which can only be shown in the vertical plane, such as the action of pouring a liquid from a drop-bottle, the burning of a match, etc.

The elements of the lantern may also be combined to project any transparent object, such as ordinary lantern slides and coloured photographic plates.

It should be mentioned that by using two daylight micro-projectors and two resistances (to vary the electric current and therefore the intensity of the light), dissolving views of the greatest beauty (flowers, insects, precious stones, etc.) can be obtained, as with glass slides.

A Roman Gentleman

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The private correspondence of a prominent personage of a past era is never without interest, shedding, as it must do, an intimate light upon the society in which the writer moved. If the man of affairs be also a man of letters, if he be a Horace Walpole or a Pliny, there is an added pleasure in its study.

The Younger Pliny, as he is generally called, was born at Como in A.D. 61 or 62. Though belonging to the Italian rather than to the Roman aristocracy, his family was well-to-do and had been of local importance for several generations. His guardian, for his father died when Pliny was a boy, was Verginius Rufus, the most distinguished general of his day, a man who had twice refused the wishes of his troops to make him a candidate for the imperial throne. He was adopted as his heir by his uncle Pliny the Elder, the scholar and antiquary who met his death, a martyr to his scientific interest, in the great eruption of Vesuvius which buried Pompeii and Herculaneum in A.D. 79. After studying under the great professor of rhetoric, Quintilian, Pliny was called to the Bar and rose to distinction upon what we should call the Chancery side. He was clearly an indefatigable worker, careful, even meticulous, in his attention to detail. In several important cases arising from charges of provincial misgovernment, Pliny was retained for the prosecution, and when in A.D. 111 the Emperor Trajan found it necessary to send out a special commissioner to reform the administration of Bithynia, which had fallen into grave disorder, Pliny, whose conduct of these cases had given him considerable knowledge of provincial administration in general, and, as it happened, of Bithynian conditions in particular, was wisely selected for the task.

The correspondence, then, consists of the letters of a leading barrister and a distinguished public servant who was born in the middle of the reign of Nero and died shortly before A.D. 125. Except for those which as special commissioner he exchanged with the emperor, and which throw an invaluable light upon the provincial administration of the period and incidentally upon the attitude of the Roman Government towards the rising sect of Christians, the main interest of these letters is not political. It lies rather in the characters of the writer and his friends; and the qualities which they display are not the less remarkable because Pliny is self-revealed as in no sense an exceptional personality but as one man whose character reflects the virtues of his type and class. For the impression of society which Pliny gives us is very different from that popularly derived from novels like *Quo Vadis* or cinematograph representations of Christians in the arena. It is different, again, from that conveyed by the satirist Juvenal, whose material was the same society, but who saw it from the different angle of Grub Street or from that presented in the gloomy masterpiece of Pliny's friend Tacitus. Now, it may be true that Pliny does not give us the whole picture, but neither do satirist or historian, and it is pleasant to be reminded by these letters that Rome possessed an upper class many of whose members were cultured, humane, upright, kindly, and generous.

Pliny, of course, has his weaknesses. He is patently vain about his literary compositions and his eloquence in the courts. But he is so frank about it that he disarms criticism, and if he thoroughly appreciates the merits of his own compositions, he is equally generous towards the literary efforts of his friends. He expects them to sit through and applaud the interminable recitations of his speeches or verses, but he is himself punctilious to form part of a friendly audience for them in turn. He is at times a bit of a prig, but he recovers himself with a fine tolerance. "Let us, then, make allowances for what pleases other people, so that we may induce others to make allowance for us!"

Of his upright character he gives us more than one illustration. Although a lawyer by profession, he is never anxious to press the strict letter of the law to the detriment of equity. For instance, a friend, half of whose property he inherited, had left written codicils which for formal reasons were not legally valid. "I have made a law of my own for such cases," writes Pliny, "which leads me to treat as valid the wishes of the dead man, even though they are not legally binding upon me." In business matters, too, he acts with generosity. Dealers upon one occasion had bought up his vintage in prospect. The crop and market failed them and they were faced with considerable loss. Pliny thereupon very generously remitted an eighth of the purchase price to all, making additional remissions to those who had been the largest buyers.

His relations with his servants are marked by kindness and humanity. There were, of course, brutal masters. Pliny tells of the fate of one who was murdered by his exasperated slaves in the bath, and refers to another acquaintance who set out upon a journey and mysteriously disappeared, while the servants who accompanied him were never seen again. But Pliny can have had little to fear from his "family." His slaves are not chattels, but human beings and humble friends. "I have been greatly upset," he writes, "by illness in my household, some of my servants having died and at an early age. I have two consolations which, though they are by no means equivalent to my grief, do certainly afford me comfort. One is that I have been generous in giving them their freedom—for I do not consider that I have lost them altogether immaturely when they died free men—and the other is that I allow my slaves to make as it were valid wills, and I preserve them as I should strictly legal documents. But though I have these consolations to make my mind easier, I feel shattered and broken by just that same sense of common humanity which led me to grant them these indulgences."

There are constant references in his letters to his solicitude for his freed-men, his affectionate appreciation of their good qualities and his anxious care for their welfare. Zosimus, a favourite reader and comedian, is sent to Egypt for a cure, and upon a recurrence of his malady, Pliny sends him to a friend's farm, where he can hope to benefit from the country air and good milk. His old nurse he pensioned off with a small property, and begs a friend to look into the business side of it for her.

Pliny's relations with his young wife are wholly delightful. Their happiness was only clouded by the lack of children which they ardently desired. Although much younger than her husband, whose third wife she was, Calpurnia threw herself completely into his interests. "I feel perfectly assured," he writes to her aunt, "that our mutual happiness will be lasting and will continue to grow day by day." When she is absent, Pliny is miserable. "It is incredible how I miss you," he tells her, "such is the tenderness of my affection for you and so unaccustomed are we to a separation! I lie awake the greater part of the night in conjuring up your image, and by day (to use a very common but very true expression) my feet carry me of their own accord to your apartment at those hours I used to visit you; but not finding you there, I return with as much sorrow and disappointment as an excluded lover. The only intermission my torment knows is when I am engaged at the Bar and in the causes of my friends." This charming picture of domestic happiness is a pleasant corrective to Juvenal's savage onslaught on the monstrous "regiment of women" in his sixth satire. Nor was Pliny's case a unique phenomenon in Roman society. His friend Macrinus and his wife had "lived together for thirty-nine years with never a quarrel or disagreement" before death separated them.

Pliny had clearly a genius for friendship. He has a genuine affection for his friends, and his sympathy in their joys and sorrows is patently sincere. He is always ready to do anything for them, and will not spare himself in their service, whether it be the exercise of political or professional influence in their favour or the selection of a tutor or a husband for their children. He tends to see the best of people; his appreciations are warm, his testimonials glowing.

He shows, too, a nice feeling. He is particularly fond of helping and encouraging the younger men in his own profession. With money he is extremely generous, and what is more, shows a delicacy in the manner of his giving. The daughter of his old teacher, Quintilian, was being married to a man of some position, and her dowry, so Pliny tells her father, should be sufficient to enable her to maintain her rank. "Now, as I am sensible your material wealth is not equal to the riches of your mind, I claim to myself a part of your expense and, like another father, endow our young lady with 50,000 sesterces. My contribution should be larger but that I am well persuaded the smallness of the gift is the only inducement that will prevail with your modesty not to refuse it." To a lady who had discovered and offered to rectify a generous deceit by which Pliny had charged her 700,000 sesterces for a property assessed for revenue at 900,000, he replies, "I must desire and insist in my turn that you will consider not only what befits your character, but also what befits mine and will suffer me to oppose your inclination in this single instance with the same warmth that I obey it in all others."

If his purse was always open to relieve the wants of a friend or dependent, Pliny was no less generous in public benefaction. His native place was very near his heart, and though Como was not the sole recipient of buildings at his expense, it is to his birthplace that his most interesting gifts were made—the creation of a library and the endowment of a fund for its upkeep, the provision of a fund for the education of poor children and the creation of a school. In the age of the Antonines, as in our own, the wealthy recognised the responsibility of their riches and were generous givers. The tendency of the time was towards the increasing provision of public institutions for the care and education of children, the encouragement of maternity, and the maintenance of the aged and infirm. It is interesting to notice, however, a marked difference of opinion between Pliny and a recent benefactor of Scottish universities. The inhabitants of Como had previously been obliged to send their sons to Milan for want of a local school. Pliny determined to remedy this. He initiated the scheme for creating a good local school, and spent some trouble, enlisting the help of Tacitus in the matter, upon securing an adequate staff. But he shrewdly refused to find more than a part of the endowment necessary, not because he grudged the money, but because in his view, as he told his fellow-townsmen, parental responsibility counts for something, and people value more and take a more efficient interest in an institution to the cost of which they contribute themselves. "For though parents may be careless in disposing of another's bounty, they will certainly be cautious how they apply their own, and will see that none but those who deserve it shall receive my money, when they must at the same time receive theirs too."

It will be seen that the general reader who turns to Pliny's *Letters* for the first time will be likely to modify his conception of the manners and morals of pagan aristocracy at the turn of the first and second centuries. He may also find plenty of entertainment and plenty of good things in the book. There are interesting vignettes of social types like the well-read country gentleman (viii. 25), or the eccentric old lady of lurid tastes with her private company of farce-actors and her exemplary grandson (vii. 24). There are charming sketches of Italian country written with a feeling for scenery which is rare in classical authors. There are the two letters to Tacitus describing at first hand the great eruption of Vesuvius. There is a famous ghost story, and finally there is the marvellous relation of the wonderful dolphin of Hippo (ix. 33), a theme which is worthy, though I do not think he has made use of it, of the treatment which Anatole France alone could give it.[1]

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[1] Handy and inexpensive pocket editions of Pliny's *Letters* are the translation by J. B. Firth, published by the Walter Scott Publishing Co., and the text and translation edited by W. M. L. Hutchinson for the Loeb Library. Though I have made use of both above, the second is perhaps preferable, for not only does it give the Latin text opposite the translation, but the latter is a revision of an English classic, the translation of William Melmoth first published in 1746.

For the social conditions of the period Dill, *Roman Society from Nero to Marcus Aurelius*, and Friedlaender (translated by Magnus), *Roman Life and Manners under the Early Empire*, may be consulted.

Recent Advances in our Knowledge of the Sun

By the Rev. Hector Macpherson, M.A., F.R.A.S., F.R.S.E.

SOLAR astronomy, as a distinct branch of the science, dates from the closing years of the eighteenth century. The elder Herschel, amid his multifarious investigations, found time for the systematic study of the solar disc; and to him is due the credit of enunciating, as the outcome of his scrutiny of the spots and faculæ, the first "solar theory" worthy of the name, a theory which, although fallacious, acted as a stimulus to further investigation. In the history of solar research since Herschel's time, three well-defined periods may be traced. The first, which may be designated the telescopic period, opened in 1826, when Heinrich Schwabe, the amateur astronomer of Dessau, began to count the number of spots visible daily on the solar disc, an investigation which ultimately resulted in the discovery of the solar cycle—the increase and decrease of the number of sunspots in a period of about eleven years—which was shown to be synchronous with the period of terrestrial magnetic variation. In this period, too, Carrington, in England, and Spörer, in Germany, independently discovered the remarkable equatorial acceleration of the sun. They showed that the sun's rotation period increased from about 25 days at the solar equator to about 27½ days midway between the equator and the poles.

The second, which may be called the spectroscopic period, opened in 1859, when the newly-invented spectroscope was applied by Kirchhoff to the study of the sun, and the sub-science of solar physics was born. By means of the spectroscope many of the familiar terrestrial elements were identified in the solar atmosphere. The spectroscope was also applied by Janssen and Lockyer to the daylight study of the solar prominences, those red flames which were formerly revealed only on the rare occasions of total eclipses. The systematic work of the Italian school of spectroscopists—Secchi, Respighi, Tacchini, and Riccó—brought out the significant fact that the number and distribution of the prominences were governed by the same law as the spots; in other words, obeyed the solar cycle. Perhaps, however, the application of the spectroscope to the measurement of motion was the most important development during this period. In 1842 Christian Doppler, of Prague, pointed out that, theoretically, the colour of a luminous body should be changed by motion of approach or recession, just as the sound of a sonorous body is altered; the change in colour, however, is so slight as to be imperceptible; what actually happens is a slight shift of the entire spectrum in one direction or another. There is, therefore, a displacement of the spectral lines in one direction if the source of light is approaching, and in another direction if it is receding. The application of Doppler's principle to the measurement of the rotation and atmospheric motions of the sun was one of the epoch-making advances in this period. In the hands of Dunér, the Swedish astronomer, the spectroscope confirmed the discovery by Carrington and Spörer of the sun's equatorial acceleration, and indicated that its rotation period was protracted to about thirty-eight days near the poles. Measures of the velocities of prominences were also secured by Young and others.

In 1891 the third period of solar research was inaugurated. It may be called the spectroheliographic period, from the instrument which in that year became the invaluable adjunct to telescope and spectroscope. The spectroheliograph was devised independently by Professor George E. Hale, now director of the Mount Wilson Observatory, in California, who was then in charge of a private observatory near Chicago, and by M. Henri Deslandres, of Meudon, near Paris. The principle of the spectroheliograph has been lucidly explained by Professor R. A. Sampson, in his admirable little monograph *The Sun*, in the following words: In a spectrogram, or photograph of a spectrum, "each line is a record of the presence and state of a separate chemical element at the spot of the disc to which the slit is directed. If this record could be read for that special line for the whole disc, we should have the same information summed up for the whole sun. . . . Let the light from the line in question be allowed to pass to the photographic plate, by means of a second slit, at the focus of the camera, the jaws of which shut off all the rest of the spectrum. Let both the first and the second slits be long enough to extend right across the image of the sun. Move the image of the sun across the first slit, then the light which passes through the second slit will come at every moment from different strips of the sun's surface; and if the photographic plate be moved behind the second slit, in unison with the movement of the sun's image across the first slit, a record will be given, not of the radiations of every substance mixed together, as in ordinary photographs or visual observations of the sun's disc, but of the states of some isolated substances as calcium or hydrogen, and even of different strata of these."

The early work both of Hale and Deslandres was largely experimental. Both astronomers were handicapped by limited opportunities and instrumental means. In 1908, however, on the assumption by Deslandres of the post of director of the Meudon Observatory, that institution was thoroughly re-equipped, and the director began the construction of a large spectroheliograph "to reveal the superior layers of the chromosphere[1] by the aid of the light of calcium and hydrogen." In addition to the spectroheliograph, Deslandres devised an instrument which he called the "spectro-enregisteur des vitesses"—the velocity-recorder. With this form of spectroheliograph it is possible to determine, by means of Doppler's principle, the radial velocities all over the disc, indicating which vapours are ascending and which are descending. As a result of the work of Hale, Deslandres, and other observers—notably those working under Hale at Mount Wilson—it is now possible to speak as Deslandres has done of the "progressive revelation of the entire atmosphere of the sun." The last twenty years have been a period of unparalleled progress in solar astronomy. The new methods, for instance, have thrown a flood of light on the nature of the solar spots. These spots were among the first-fruits of Galileo's little refractor, and have been under telescopic observation for over three centuries. It is indeed somewhat remarkable that, although they were observed carefully for two hundred years by astronomers of such consummate skill as Cassini, Wilson, and the elder Herschel, their periodicity was not discovered until Schwabe, with a small hand telescope, began to count their numbers from day to day. The telescope, unaided by its modern adjuncts, however, was of little use for fathoming the mystery of the constitution of the spots. For many years Wilson's classical theory of the nature of the spots was widely accepted. This hypothesis, which was adopted by Herschel, maintained that they represented depressions below the surface of the solar photosphere. Careful observation in the latter half of the last century, however, led a number of competent investigators first to doubt and latterly to challenge the accuracy of the theory. In 1904 the late Professor C. A. Young, of Princeton, cautiously pointed out that "as regards the sun-spots it seems no longer safe to assume that they are always depressions in the photosphere." More definite was the conclusion reached by Dr. Abbott in 1911, that "it seems most probable that the level of the sun-spot phenomena seen by ordinary observers differs very little, if at all, from that of the surrounding bright surface of the sun."

By 1903, the development of the spectroheliograph permitted the photography of hydrogen clouds as well as calcium. In the spring of 1908 Hale, at Mount Wilson, made the interesting experiment of photographing the sun in the red light of hydrogen. These photographs revealed whirling storms in a region of the solar atmosphere higher than that of the calcium and lower hydrogen clouds. This gave strong support to the hypothesis of the vortical nature of sun-spots. "We know now," said Hale in November 1908, "that they are caused by vortices in the solar atmosphere, and the various theories which do not recognise this fact may be laid aside." At that time, Hale inclined to the view that "in the case of sun-spots we see a phenomenon somewhat analogous to a tornado or waterspout on the earth. If the gases at high levels whirl with sufficient velocity, they develop a tube-like extension which reaches down through the comparatively undisturbed gases at lower levels. At the centre of the storm the expansion of the gases due to their rapid rotation cools them and thus produces a comparatively dark cloud which we see in the sun-spot." At that time Hale believed the disturbances giving rise to the spots to have their origin in the upper regions of the solar atmosphere. This view he modified later.

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[1] The photosphere is the luminous envelope of the sun. The chromosphere is the gaseous envelope of the sun through which light passes from the photosphere.

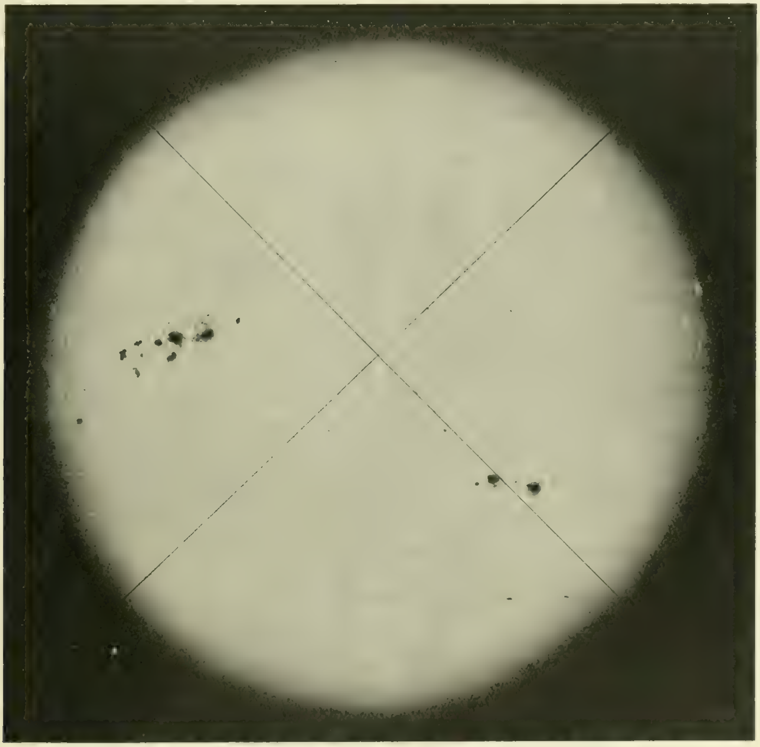

PHOTO OF SUNSPOTS TAKEN AT GREENWICH OBSERVATORY, MAY 1921.

(By kind permission of the Astronomer Royal.)

Experiments conducted by Rowland at Baltimore as far back as 1875 indicated that, if electrically-charged bodies existed at all in the solar atmosphere, their revolution in sun-spot vortices would produce a magnetic field; and in 1896 Zeeman, of Amsterdam, showed that the light from a luminous vapour is altered in a remarkable way when under the influence of a strong magnetic field—the lines of the spectrum being widened or broken up into several constituents (the Zeeman-effect). With the aid of the 30-foot spectroheliograph of the Mount Wilson Observatory, Hale, in 1908, closely scrutinised the spectra of sun-spots for traces of the Zeeman-effect, and his scrutiny was soon rewarded by the discovery that the double and triple lines in these spectra are exactly similar to the lines produced by the presence of a magnetic field. In the annual report of the observatory for 1909, Hale was able to announce that the existence of magnetic fields in sun-spots "has been placed beyond doubt through the detection of all the characteristic phenomena of the Zeeman-effect. As the only known way in which such magnetic fields could be produced at the temperature of the sun, it thus appears probable that sun-spots are electrical vortices."

In 1909 a brilliant discovery was announced by Mr. John Evershed, the able English astronomer who directs the observatory at Kodaikanal, in India. He detected displacements of lines in the sun-spot spectra, which indicated, on Doppler's principle, the existence of large radial motions in spots—the movement of gases outward from the centre of the spots and parallel to the photospheric surface. In the summer of 1910, Dr. C. E. St. John, at Mount Wilson, commenced a more elaborate investigation, and after two years he confirmed Evershed's discovery and put forward a hypothesis of its significance. "We are dealing," he said, "with an actual flow of the material of the reversing layer out of spots and of the chromospheric material into spots." In the light of these disclosures, Hale's original sun-spot hypothesis was obviously untenable or at least only partially true. Accordingly, in 1912, he outlined what he called a "tentative working hypothesis" as "a guide to further research." According to this theory a column of gas moves upward from the interior of the sun towards the surface of the photosphere. Owing to differences of velocity of adjoining surfaces or irregularity of structure, a vortex motion is set up. The circulation in the vortex is vertically upward and then outward. As a result of expansion in the central portion of the vortex, cooling sets in, and a comparatively dark cloud—the sun-spot umbra—is formed. "A rapid flow of negative ions sets in towards the cooler gases at the centre from the hotter gases without. These ions, whirled in the vortex, produce a magnetic field."

The systematic study of the chromospheric regions—comprising prominences, faculæ, and the higher levels of the solar atmosphere—has been carried on in recent years by Deslandres, Evershed, and the Mount Wilson observers. Evershed's work on prominences has supplemented the earlier work of Tacchini and the Italian spectroscopists. From 1890 to 1906, observing in England, Evershed recorded 11,000 prominences, and from the commencement of his work in India until 1917, 60,000 were numbered and investigated. Evershed confirmed the conclusion of the Italian astronomers with regard to the general identity of the prominence-period with the spot-period. He distinguishes two classes of prominences—"large high prominences" and "prominences associated with sun-spots." The large and massive prominences are not found directly above spots, while prominences of the second type are invariably associated with these objects. The application of the spectroheliograph has now made possible the observation of prominences not only on the edge of the sun, but all over the disc. Allied to the prominences are filaments and alignments in the higher regions of the solar atmosphere to which Deslandres has devoted much attention since 1906. These form a kind of network over the disc. Again and again, Evershed has noticed that at a point of the limb where a prominence is visible, a filament or alignment usually ends. Evershed, indeed, identifies filaments with prominences projected on the disc of the sun. Indeed, prominences, alignments, filaments, faculæ, and flocculi seem to be different varieties of the same species, at different depths of the solar atmosphere and of varying degrees of permanence. Undoubtedly the most ephemeral of all solar phenomena are the hydrogen "bombs," first noticed by Mr. Ellerman at Mount Wilson on September 21, 1915. The average duration of these is from one to three minutes, and on rare occasions from five to ten. "The appearance of the phenomenon," wrote Ellerman in 1917, "indicates something in the nature of an explosion, in which hydrogen seems to be the only element playing a part. . . . The regions where the bombs are likely to appear are around and among active spot-groups, especially groups which are developing and composed of many members."

Research work on selected areas and different levels has enormously increased our knowledge of the solar atmosphere, and of its components and circulatory processes. The rarer and heavier elements appear to be confined to the lower levels and the lighter and more abundant gases form the upper layers. St. John's study of the distribution of the elements in the solar atmosphere indicates that the lower solar atmosphere, including the lowest region of the reversing layer, is a highly disturbed region, in which are located the upper parts of the sun-spot vortices, where the outflow of material from the interior takes place. Higher than this is the general reversing layer, and higher still the chromosphere. Beyond the chromosphere is the corona. Unlike the chromosphere, this outer envelope is always screened from view except on the rare occasion of a total eclipse of the sun. Many attempts have been made, by various methods, to photograph the corona in daylight, but these have been so far without success. At an early stage, it became apparent that the shape of the corona is governed by the solar cycle. At maximum the coronal radiance is equally distributed all round the sun's disc, while at minimum long streamers from the equatorial zones make their appearance. The study of the corona has made much less progress than that of other solar appendages, and accordingly its nature is still largely a matter of conjecture. The coronal spectrum was long ago noticed to be compound, indicating that it shines partially by reflected light from the photosphere and partly by its own inherent light. It has been generally conceded that electrical action has much to do with the nature of the corona, though Arrhenius and others have insisted on the part which radiation-pressure plays in its production. Professor Perrine, in 1918, expressed the view that the matter composing the corona, with the exception of the portion which gives a bright-line spectrum, exists in the form of small solid and liquid particles, and that this matter shines by its own radiance, while the outer corona shines by reflected light. The greater part of the motions within the corona, according to Perrine, is due to mechanical causes, explosions, light-pressure, and gravity, while he holds that the view that the arrangement of the coronal streamers results from magnetic and electrical causes is not improbable. During the total solar eclipse of June 8, 1918, the Lick Observatory expedition, headed by Professor Campbell, secured a number of photographs which revealed arches of coronal matter surrounding the principal prominences, indicating the probability that the structure of the corona is largely dependent on the forces producing the prominences. That these forces are in great measure electrical and magnetic admits of little doubt.

In two papers, published in 1904, Mr. E. W. Maunder, of Greenwich, brought out some remarkable facts concerning the connection between the sun-spots and terrestrial magnetism. In the first paper he showed that, "of the nineteen great magnetic storms recorded at Greenwich from 1875 to 1903, all the nineteen, without exception, took place when there was present on the sun a group of spots with projected area of over 1,000 millionths of the area of the whole disc ; or when a group at one time very large had returned in a diminished form to the central meridian." In his second paper, which has been said with justice to establish "an entirely new conception of the solar action in producing our magnetic disturbances," Maunder showed that the cause of the magnetic disturbances is associated with limited areas on the solar surface. The magnetic action, he finds, does not radiate equally in all directions, but along definite and restricted lines. Thus, stream-lines from many spots may miss our earth altogether, and thus a great spot need not necessarily be accompanied by a magnetic storm. Maunder found an analogy to these hypothetical stream-lines in the long rays of the corona ; and while not committing himself definitely, evidently inclined towards the view of Arrhenius that the streams consist of droplets formed by condensation in the solar atmosphere negatively charged and driven away by radiation-pressure. This hypothesis he spoke of as "entirely consistent with the appearance of the coronal photographs and with the conditions indicated by the magnetic storms."

Many of the problems presented by the sun seem at the present time as far from solution as ever. For instance, the cause of the equatorial acceleration, which has been aptly called a "legacy from chaos to cosmos," is yet unexplained ; the reason of the solar cycle, too, is obscure, although probably its explanation is to be found in the fact of solar variability. That the sun is, to a very slight extent, a variable star seems to be definitely established by the researches of Abbott, whose measures of the solar constant indicate a real variability in radiation outside of, and independent of, the terrestrial atmosphere.

"The sun," Abbott concludes, "excepting perhaps in sun-spots, is wholly gaseous or vaporous. Except in sun-spots, the photosphere is too hot to contain solids or liquids. The density of the gases rapidly diminishes and their temperature rapidly falls from within outwards across the apparent boundary of the sun." Astronomers differ as to whether or not the temperature falls sufficiently to allow of condensation. Young maintained throughout his career that the solar photosphere consists of an envelope of clouds formed by the condensation of the solar vapours cooled by radiation into space. "The photospheric clouds are, of course, suspended in the surrounding gases and uncondensed vapours, just as clouds float in our own atmosphere." Abbott believes, on the contrary, that no condensation can take place at a temperature which exceeds 6,000° Absolute Centigrade. He accepts the view of the late Dr. Scheiner that the bright grains of the photosphere are the wave-crests of gaseous currents of different temperatures.

The impression made on the terrestrial observer by the sun is one of almost inconceivable magnitude and power. The great volume of the sun, over a million times that of the earth, its enormous mass, and the mighty forces which are at work in the solar globe, dwarf our planet and all our activities to insignificance. Yet modern astronomy has shown that the sun is a very insignificant member of the stellar system. The majority of the bright stars which illuminate our night skies are globes immeasurably superior to our "orb of day." Betelgeux, the size of which was measured in December last at Mount Wilson by interferometer methods, has a diameter of 273,000,000 miles, so that if we could conceive the gigantic star placed in the centre of our solar system, not only Mercury and Venus, but also our Earth and Mars would revolve within its circumference. Compared to these stellar giants, our sun belongs to quite an inferior order of celestial bodies ; and our earth, which seems to us the end and aim of creation, turns out to be but a dwarf planet revolving round a dwarf star.

Past and Present

By O. G. S. Crawford, B.A., F.S.A.

ARCHÆOLOGY is the last subject to which one might think of attributing any direct practical value; yet it has, I submit, two very real claims thereto. It has a subjective value in producing a certain state of mind in its students; and it has an objective value because it helps to explain the origin of certain "subconscious" instincts which control our actions.

Let me take the subjective value first. Archæologists deal primarily with time in large stretches; they use man's primitive tools and weapons as tallies for measuring his progress, and they grow accustomed to the vista of long ages with scarcely perceptible change. Now, it is impossible to do this without being struck by the immense power of conservatism which throughout the past has kept the craftsman strictly to his ancestral model, and which has ordained that the new must disguise itself as the old if it is to survive. These are commonplaces, but they are necessary to my argument; for I wish to make it clear that archæology, by revealing these processes of tool-development, does so to expose their cumbrous and wasteful nature. Tools—in the widest possible sense of that word—are a means of attaining a certain end. Primitive man was fully conscious of the ends he had in view when he was making a stone axe or a sickle; but instead of conducting research experiments to determine the best kind of axe or sickle for his purpose, he slavishly followed the ancestral type. (What was good enough for his father was good enough for him, and so forth, a dictum reinforced, doubtless, by the elders of the tribe.) The survival of the fittest would, of course, operate in favour of the axes best suited, in shape or material, to achieve their purpose; but the natural law would operate infinitely slowly and in a haphazard manner. Primitive man is not extinct; his voice is heard whenever the results of competition in the open markets of the world are claimed to be better than those achieved by deliberate, organised scientific research. The "open market" policy was the rule of the Stone Age. Its underlying assumption was that men, though capable of selecting the best axe for their purpose, when it was made, were incapable of deliberately setting out to improve it by rational collective effort.[1] I am not blaming the men of the Stone Age for what was the necessary result of their primitive social condition. But the lesson of the last hundred years is that such collective effort, even when despised and rejected by "practical" men, is the *only* line of progress open to civilised communities.

There are only two types of men, conservatives and liberals, as Gilbert said. The conservative is ruled by precedent; he is seldom open to conviction and not always rational; the liberal, on the other hand, does not shy at a new suggestion merely because it is new and strange; he accepts or rejects it on its merits. During the earlier half of the first millennium before Christ, Britain was inhabited by conservatives who continued using bronze after iron was known and used by their Continental neighbours. (This was due to the vested interests of her copper and tin industry.) About the middle of this period some enterprising merchant of radical tendencies appeared in Wales. He knew about iron and could make tools of iron, but he was unable to dispose of them to his conservative customers. He therefore adopted an amusing stratagem. With great labour he made iron spears and sickles of exactly the same shape as the bronze ones which his customers were in the habit of buying, and to complete the deception he dipped them in molten bronze. He mixed up these counterfeits with genuine objects of solid bronze and took them all away with him on a journey. But his radical enterprise (to give it no worse a name) met with disaster, for he dropped the whole bagful of tricks into a lake. Had he not lost them, however, we should not have known of his enlightened efforts, nor should we be able to see them, as we now can, in a show-case at the National Museum of Wales.

Another subjective result of the study of archæology is the attitude it produces towards current events. One has to deal with the migration of peoples and with their evolution throughout long periods of time. One's outlook is, habitually and of necessity, a broad one in both time and space. More particularly one is constantly brought up against that strange, distressing phenomenon—the rise and fall of civilisation. (I assume that the archæologist is also interested in and familiar with the main outlines of historical development.) History and archæology alone can hope to explain this phenomenon; and when it has been explained, when its causes are discovered, we shall be half-way towards its cure. There, at any rate, is a fine practical problem to be faced! The present time is a most suitable one in which to make a start. Anyone who could find an explanation and a solution of our present troubles would, I am sure, earn the gratitude of Mr. Lloyd George, and might even hope for a good word from Lord Northcliffe, Mr. Horatio Bottomley, and other great leaders of thought. It is generally assumed that civilisation is declining and that we are re-entering the Dark Ages. But those whose historical memory is capable of the effort are puzzled by the absence of the usual barbarian hordes waiting outside the gate to overwhelm us. Hitherto they have never failed to appear when the time was ripe for them—the Northerners in Crete, the Goths in Italy, and the Saxons and Danes in Western Europe. But now it seems that it is the stranger *within* our gates who is to set back the hands on the dial of progress. With unerring intuition our middle classes have divined the foe in what is conveniently summed up by the term Bolshevism. Nearly all the old familiar associations are present—the lower culture and the desire of loot, the destruction of idols and conversion by the sword. Only one is absent—the migration of large bands of people and the conquest and settlement of alien territory by people of the lower culture. But since nowadays the contending parties occupy the same geographical area in each instance, this migration is unnecessary, and the looting is also easier.

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[1] "Research may be defined as the process of intentionally looking for something new; the value of some physical constant, a new material, or a method of performing some operation." F. H. Norton on "The Conduction of Research," *Scientific Monthly*, May 1921

I have taken Bolshevism as a convenient example to show how the present can be interpreted in the light of the past. It is not possible to develop this theme here; but before passing on, I must refer to another, more general aspect of the same phenomenon. What has been the chief characteristic of these set-backs? Surely it was the making of a *fresh start* after each. After a blank period the writing begins to appear again upon the wall. To vary the metaphor, it is as if civilisation were unable to keep going continuously, but needed, like a living organism, long periods of sleep. It is as if men awoke after such sleep refreshed and full of vigour, remembering but dimly the days of long ago, and ordering their conduct without reference thereto. Conduct thus freed from the iron chains of precedent was easier and life at the dawn of history far simpler than nowadays, when we are crippled by the burden of a vividly remembered past. " Happy is the people without a history "; but to have had a past and to have forgotten it is, for a community, a still more blessed state. The accumulation of files and records complicates social life, and if continued long enough, may crush it by its dead weight. It is to society what memory is to the individual, or notes to the man of science.[1] Every research student knows that the chief difficulty in producing constructive work is to keep one's notes subordinated to one's purpose, to *defeat* them and fuse them into a living structure, to prevent them at all costs from terrorising and overwhelming one. When records, notes, or precedents outgrow the power of the individual and of society to deal with them thus summarily, the latter become sterile and rapidly degenerate into a mechanical rigidity. Reactions become automatic instead of intelligent; plasticity is lost and adaptation to environment ceases. When such a state of intellectual paralysis is achieved, no more is possible in that incarnation.

Let it not be supposed, however, because a period of " sleeping and forgetting " has hitherto been necessary, that it must always be necessary. It has been necessary in the past because things have been allowed to drift, because those at the helm have lost their bearings and surrendered to the blind forces of nature. Let me take from English history an example of what I mean by saying that it is sometimes a good thing for a society to forget its past. One of the most complicated transactions at the present day is the transfer of land from one owner to another. Why is this so? Because the method of transfer has persisted almost unchanged since the seventh century of this era, and this in spite of the fact that the community has caused to be prepared, for the express purpose of simplifying this procedure, an unrivalled set of large-scale plans of the whole country. But a small section of the community, with vested interests, has frustrated the intentions of the whole community, and persists in smothering under an unintelligible ritual of expensive jargon what should now be a perfectly straightforward business. It is difficult to see how these legal gentlemen are to be cured of their Anglo-Saxon habits without having an operation performed upon them by the rest of the community.

The history of our own country during the last millennium provides more than one example of the recurrent necessity for a " clean sweep." When the customary services of feudal times became intolerable, they were commuted for in money payment, which still survives as rent (only that nowadays one need not have Norman blood to be a landlord). But the extraordinarily involved allotment system of the common fields long outlived its original purpose, and was not finally swept out of existence until the Enclosure Acts of the eighteenth and early nineteenth centuries. (It still survives, I believe, in a few out-of-the-way places.) The Enclosure Acts may have borne hardly upon a few individuals, and upon the community as a whole in the loss of common lands; but the trend of modern expert opinion is to regard the injustice and loss as grossly exaggerated, and the national gain in efficient agricultural control as well worth the sacrifice.

The examples I have given show the value of an historical and archæological perspective in regarding questions of modern policy. Let me now deal with the objective value of this department of knowledge.

Every student of comparative anatomy knows that the human body is a museum of relics which have been acquired at various times during our evolution. All of them were once functional, but are now dormant, or awake only, like the appendix, to cause trouble. But it has been reserved for modern psychologists to discover—and promptly to obscure again by an unnecessary jargon—the equally obvious corollary that what is true of the body is true also of the mind and the nervous system. The sportsman inherits from the cave man not only his powers of physical endurance, but also his love of the chase. The capacity for co-operation is a legacy from necessities of prehistoric warfare; but so also is the herd-instinct with its blind cruelty to non-conforming individuals. We cannot eradicate during a few years of civilisation the habits that were formed during countless ages of savagery. Trite as this remark may seem, it has taken mankind a very long time to discover and elaborate its full implications. One of these is, that in order to eradicate, we must first learn what exactly it is we wish to eradicate. This can only come from a more detailed knowledge of our primitive ancestors and their environment. When we know how they passed their days and what their chief preoccupations were, we shall be able with greater certainty to infer their dominant instincts. From living primitive peoples we can find out a good deal by analogy, that is to say by the methods of comparative anthropology. But as Mr. Hocart pointed out (*Hibbert Journal*, 1919), there are pitfalls in this method. In a general sense, the comparative method, which is the method of Tylor, is, of course, valid; but we must be cautious in assuming in any given case that the culture in question represents a stage through which the human race as a whole—or any portion of it—has passed. It may be a degenerate stage, on the point of extinction. We once believed that Neanderthal man was on the direct line of our evolution, but now we know that he is not. (A more careful study of anthropoid embryology might have saved us from this error.)

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[1] Samuel Butler called his note-books his "externalised" or "extra-corporeal" memory.

To the student who is thoroughly inured to thinking in terms of millennia or centuries, this discovery of repressed or half-buried instincts by the psychologists comes as no surprise. One would like, however, to see the relative potency of these instincts more fully worked out, and some system of classification applied to them according to the length of their pedigree. In the more obvious cases (such as the sexual instinct) it is obvious that great power and a long pedigree are combined. If this is so, it should be true also that instincts with a short pedigree are less formidable, and more easy to subdue or divert into harmless channels until they exhaust or transform themselves. That such transformation is possible is now generally agreed. If, for example, archæological research proves, as it well may, that organised warfare is an institution of quite recent origin, we shall have a strong case against those who say "war has always been and always will be." Ultimately this line of argument is based always upon an assumed ineradicable instinct of pugnacity, developed by age-long immemorial strife between man and man. This assumption is quite unwarranted, and, in fact, unwarrantable in the light of modern research, which reveals abundant evidence of strife between men and animals, but none of strife between men and other men until quite recent times.

The long dark ages, when man was merely an animal, and the shorter twilight years when he was only half human, were the breeding-ground of the instincts we inherit but are only dimly conscious of. When these ages are more clearly revealed to us by the light of scientific research, we shall be better able to exorcise the evil spirits they have engendered; for here, at any rate, it is most surely true that knowledge is power.

Some Geometrical Canons of Architecture

By Arthur Bowes, A.M.I.C.E.

Much has been written on the use of geometrical figures as the basis of the design of ancient and mediæval buildings, and yet the subject may be said to be to a large extent undeveloped. Only a small portion of the ground has been investigated, and there is little doubt that further research, facilitated by the plentiful supply of detailed and measured plans now available, will discover methods, hitherto unsuspected, adopted by those who were responsible for the planning and designing of important buildings in the past ages. It is scarcely necessary to say that such methods are ignored in the present-day practice of architecture, when design is a matter of individual caprice and a freedom that acknowledges no subservience to any rules or canons of musty authorities.

In the comprehensive pages of the *Encyclopædia of Civil Engineering*, by Edward Cresey, and in Gwilt's *Encyclopædia of Architecture*, will be found lucid and well-illustrated explanation of the manner in which the proportions of ancient buildings were arrived at by the aggregation of units of geometrical form. The proportions of many of the Roman triumphal arches are there shown to be based on a circumscribing square, while the same figure is found as the key-note of later work in Italy and France. The equilateral triangle and the related hexapla, or six-pointed star, are also shown to be the guiding principle in much Italian and late Norman work down to the end of the twelfth century, while the more subtle figure of the pentacle, or five-pointed star, is illustrated in ecclesiastical buildings at Rouen. An ancient cathedral or other important architectural work was in effect, then, a crystalline structure whose ultimate molecules had a definite shape, determined in each case by the root figure adopted in its design.

Nothing need be added to the full explanation given in the above-named works, though I may be permitted to refer to a more recent example as an indication of the method to be adopted in trying to find the controlling figure of the design. The Manchester Free Trade Hall was built so recently as 1856. In Baines's *History of Lancashire* the admirable great hall, noted for its acoustic properties, is described as being 134 feet long by 78 feet wide. Dividing one of these numbers by the other, we find that they are in the ratio of 1·72 to 1. Now, in the diamond-shaped figure formed by two equilateral triangles placed base to base, the foundation of the Vesica Piscis, the ratio of length to width is 1·732 to 1. In a chamber whose length is 134 feet, the width, if proportioned in this ratio, should be 77 feet 5 inches nearly, and the agreement with the published dimension is evidently so close as to justify the belief that the design was intentionally based on traditional methods. In the same chamber the height and width are in the ratio of 2 to 3, a proportion which will be referred to later.

It may be suggested here that a convenient way of detecting these and other root figures is to rule a sheet of tracing-paper into small triangles or squares as the case may be, and apply it to the published plans or elevations of the building under examination.

As to the reasons which led to the adoption of such figures, there is little doubt that in their first origin they were used from purely utilitarian motives. In *Ars Quatuor Coronatorum*, in 1906, I showed that, having regard to the want of instruments of precision, the equilateral triangle offered many practical advantages to the early builders in the setting-out of the work on the site as well as in the preparation of the preliminary plans. Great accuracy could be attained by its use on the ground, even when working with long wooden trammels or with stretched cords, and the setting-out of right angles was easily effected by constructing equilateral triangles on either side of a given line, base to base, and joining their apices. The intersecting arcs forming these two triangles constitute the correct form of the Vesica Piscis, around which many mystical associations have accumulated.

Instead of the architectural use of the above figures being founded on reverential and religious motives, consideration seems to indicate that their first adoption was a matter of practical utility, and that the association therewith of the various religious and philosophic trinities and recondite mystical symbolism was the result of a profound veneration for the wonderful properties of the geometrical figures, and, perhaps, a wish to preserve as a trade secret the knowledge of their use.

There is one root figure, a triangle possessing valuable properties of the nature referred to, that has so far escaped the notice of investigators, although when once pointed out it is impossible to avoid meeting its presence in multitudinous examples. I refer to the Pythagorean triangle, or triangle which has its sides in the proportion of 3, 4, 5. From the examples hereafter given it will be seen that this remarkable figure has formed a basis of design in architectural design work from the earliest days of Egyptian civilisation to a period of less than a hundred years ago. Its proportions can be traced in the measurements of ground plans and elevations of buildings, in the pitch of roofs, in the proportions of doors and windows, diamond-leaded panes, ventilating grilles, and other details of construction.

It may be remarked at this point that the proofs of the statement made below are matters of simple arithmetic, and to avoid any charge of dealing too sympathetically with figures in order to support a novel theory, I have in every case given the authorities from whom the measurements have been derived, so that the reader may satisfy himself of the value of the evidence offered.

The utility of this particular triangle for the purpose is easily demonstrated. It is the most suitable one for the setting-out of a right angle on a large scale—not the only one with sides in a definite ratio of whole numbers, but the one whose measures are easiest to carry in the memory and whose form best lends itself to accuracy of construction. The following triangles, amongst others, can also be used for the setting-out of a right angle:

5	12	13
7	24	25
8	15	17
16	63	65
20	21	29

but with the exception of the last the 3, 4, 5 ratio gives a better intersection of lines, and angles more fitted for practical setting-out. It is in regular use to-day in land surveying and in setting-out buildings. It also possesses other rather extraordinary properties which it is not necessary to detail here.

Two of the root triangles, having sides of 3, 4, and 5 units in length, when laid together in the manner shown in Fig. 1, form a rectangle measuring 4 by 3, and this proportion is traceable in many old buildings. Let us begin with St. Peter's at Rome. In the *Architectural Director*, a book on classic architecture by Mr. John

Billington (John Richardson, London, about 1820), it is stated that the principal nave of St. Peter's is 610 feet in length and the transverse is 457 feet. These figures are within eight inches of absolute agreement with the ratio of 4 to 3.

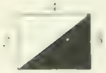

FIG. 1.

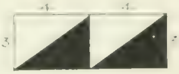

FIG. 2.

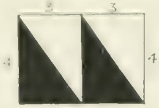

FIG. 3

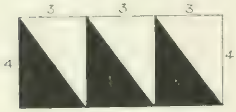

FIG. 4.

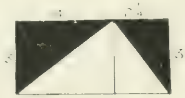

FIG. 5.

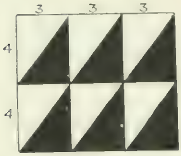

FIG. 6.

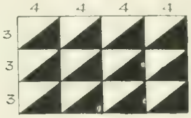

FIG. 7.

In the grottoes of Benihassen, on the Nile, are two chambers whose measurements are given as length, 52 feet 5 inches; breadth, 39 feet 4 inches. The floors of these chambers thus form rectangles in the ratio of 4 to 3, with a discrepancy of only one-third of an inch. (For measurements, see *Narrative of a Journey in Egypt*, by Thomas Legh, M.P.: Murray, 1816.)

The houses at Priene usually occupied a space of 80 feet by 60 feet (*The Planning of Hellenistic Cities*, Professor Percy Gardner; *Transactions* of Town Planning Conference in London, 1910). At Silchester the remains of the old streets can be traced, and are laid out at right angles, with one large rectangle in the proportion of 4 to 3 for the central part of the town (Professor F. Haverfield, in above *Transactions*).

In English black-and-white buildings the prevalence of this root figure is very marked in the proportions of windows, timber-framing, roof gables, and sizes of rooms. Examples will be found in Hall-i'-th'-Woods, Bolton, illustrated in *Building World*, November 27, 1915; Bamfurlong Hall, in *Building World*, January 22, 1910; Old Clergy House, Alfriston, in *Building World*, November 25, 1911. Other examples might be added from French and Italian work.

By another combination of the root triangles, in the manner shown in Fig. 2, a rectangle in the proportion of 8 to 3 is obtained. In the Bottom Chamber in the Great Pyramid the end wall is said to measure 27 feet by 10 feet 6 inches, which is within 4½ inches of the above proportion. The measurements are taken from *Chambers's Encyclopædia*.

The main hall at Hampton Court is described in Cresey's *Civil Engineering* as measuring 106 feet by 40 feet. This is within 3 inches of the theoretical length calculated from the above ratio.

The arrangement shown in Fig. 3 gives a rectangle measuring 6 by 4, or 1½ to 1. It can be traced in Moorish work, but an interesting English example is the crypt of Ripon Cathedral, which, according to Bell's Cathedral Series, measures 11 feet 5 inches by 7 feet 7 inches. In this case the calculated width is within one-third of an inch of the recorded width.

In Fig. 4 is shown how the triangles are combined to form a rectangle measuring 9 by 4, a ratio which is sometimes found in ancient work. Thus, in the *Journey* of Mr. Thomas Legh, referred to above, the excavated temple at Guerfeh Hassan is said to measure 34 feet 6 inches by 15 feet 6 inches. The discrepancy here is 2 inches from the theoretical width.

An extremely interesting example of this proportion is afforded by the Parthenon at Athens. The measurements of this building, as given in *Harmsworth's Encyclopædia*, are 227 feet by 101 feet. By calculation the width is found to be within 1⅓ inch of the recorded width.

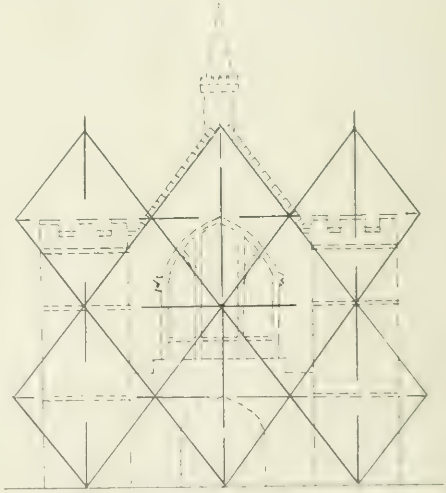

FIG. 8.

A remarkable use of the root figure is shown in Fig. 5, where three right-angled triangles, each with sides in the ratio of 3, 4, and 5, are combined to form a rectangle measuring 6¼ to 3, or 25 to 12. Now, the Temple of Zeus at Egina is said to measure 94 by 45 Attic feet, which is in the proportion of 25·068 to 12. The measurements in this case are taken from *An Apocalypse of Numbers*, by F. B. Bond (1915). The same ratios are said to be found in other Grecian and Ionian temples.

The next two combinations I have only been able to trace in ancient Egyptian work, but they are of especial interest as agreeing exactly with recorded measurements. Fig. 6, as will be seen, gives a rectangle of 9 by 8. In the old pyramid of Sakkara the base is said (*Wonderland of Egypt:* R.T.S., 1915) to measure 396 feet by 352 feet, which is exactly in the ratio of 9 to 8.

In Fig. 7 the rectangle obtained is in the ratio of 16 to 9, and this exactly accords with the measurements given of another excavated temple at Guerfeh Hassan, as recorded by Mr. T. Legh in the *Journey* before referred to.

As a last example, and as an illustration of the manner in which the 3, 4, 5 triangle entered into the design of the elevations of important buildings, apart from the arrangement of their ground plans, Fig. 8 represents the front elevation of Westminster Hall, the dimensions being taken from a fine steel plate in the *Encyclopædia Britannica*, 7th edition. On the elevation I have superimposed a network of diamonds, 4 units long and 3 units wide. Each diamond is, of course, made up of four 3, 4, 5 triangles. From the sketch it will be seen that practically all the proportions of the elevation are determined by the network of diamonds; the height and angle of the main gable, the centre lines of the side towers, the height of the towers, the apex of the entrance arch, and the position of the string courses being all determined by the various intersections of the lines forming the diamonds.

Many more examples might be added, but to those interested it will be an easy matter to compile a list of the ratios given and apply them as a touchstone to the measurements given in reliable authorities. The root figure, be it the 3, 4, 5 triangle, equilateral triangle, or its derivative figure the Vesica Piscis, can be often detected by a simple calculation. There is a peculiar fascination in thus unearthing the secret clues hidden, unsuspected as radium, for centuries. A new light is thrown on the principles which underlay so much of the art of the old creators of architectural beauty. The field of inquiry is a spacious one, and much remains yet to be revealed by patient investigation even in relation to some of the notable buildings that meet our eyes every day. Who is there, for example, of all the thousands who traverse the Thames Embankment, who could unveil the secret of the beautiful geometrical figure which shapes the proportions of Inigo Jones's stately Water Gate of York House?

Rising and Falling Prices—and a Remedy

By Arthur R. Burns, B.Sc. (Econ.)

II

THE simplest method employed in the calculation of the index number is to take a list of commodities, as far as possible unrelated to each other, and to compute from time to time the total cost of buying a given amount of each commodity. The total cost of all the commodities in the list is then expressed as a percentage of the cost at some agreed time, and this percentage is known as the index number and shows the rise and fall of general prices. Index numbers calculated in this way show that between 1789 and 1809 general prices doubled in this country and during the succeeding forty years they fell back to below level in 1789. Between 1849 and 1873 they rose 50 per cent., but between 1873 and 1896, in countries in which gold was the basis of the currency, prices fell again. By 1914 they had again risen by 35 per cent. In addition to these general movements, there have been more temporary fluctuations of the greatest importance—the economist Jevons found that for some time prices had shown a tendency to ebb and flow in a period of between ten and eleven years, and he endeavoured to connect this movement with the changes in the number of spots on the surface of the sun.

The effects of this ever-changing general level of prices, as apart from changes in the prices of individual commodities, are very serious from the point of view of both the business community and of the individual. When prices are tending to rise all those persons who hold stocks of commodities make a profit out of the increase in value of the stock between the time of purchase and of sale. Under such conditions it is easy to make profits, even for the men of small business ability, and the efficient man or firm can do well. The opportunity to make large profits induces traders and manufacturers to increase their efforts and also induces new men to compete for some of the gains (except in businesses where the high cost of the equipment required discourages them). Bankers are induced to assist by increasing loans, and the movement continues and increases in velocity, and a period of flourishing trade is experienced. If the higher prices were an indication of increased demand for goods, then the efforts to increase production would meet the demand and no ill need necessarily follow. Where, however, the high prices are merely due to monetary conditions which have caused a fall in the purchasing power of money (due to increased supply of money caused by an increase in credit circulation made by bankers), when things come to be readjusted it will be found that there was, in fact, no great increased demand for goods, and that they cannot be sold. The adjustment used to come when the bankers began to realise that they were lending too great a proportion of the customers' balances in their hands. There was then a movement (initiated in practice by the Bank of England) to cut down the loans—by increasing the rate of interest payable on them. By definitely discouraging production and making it more expensive to trade on borrowed capital, a general endeavour to liquidate stocks and restrict business would be encouraged. The effort to liquidate stocks would tend to cause a fall in prices, and producers would hold their hands. While prices are falling the holding of stocks involves a loss, and in such times only the efficient can make profits and continue to trade and avoid bankruptcy.

When stocks have been consumed and demand again makes itself felt, business optimism will gradually develop and prices again tend to rise and the " cycle of trade " will commence and go through the same phases as before. Owing to the fact that it is possible, *by altering monetary conditions,* to cause prices to rise, and to make producers think that an increased demand for their product is showing itself, they are misled and at first increase their output and then later have to restrict it. Such continual alteration causes much unnecessary strain to the financial organisation—which sometimes gives way in a crisis. It also causes irregularity of employment. Workers are able to do well in the prosperous years, but suffer unemployment at times of depression. They are now demanding that some remedy shall be found for this unsatisfactory state of affairs.

The effects of rising and falling prices upon the individual are now familiar to all. Unless wages are increased at the same time and to the same extent as the purchasing power of money falls, the workers suffer. As there is always a considerable " lag " in this respect, much discontent is caused among workers. Those who engage in long contracts expressed in money are also at the mercy of any alterations in its purchasing power. If a man takes up a policy of assurance payable at the age when he estimates that he will be unable to work and for such an amount as will keep him, if prices remain at approximately the same level, then, if the purchasing power of money falls seriously—as it did between 1914 and 1920—he may find that, although he fulfilled his part of the contract and paid his premiums in money of a high purchasing power—yet, when the policy is paid, the amount is insufficient to keep him. The other side of the problem is seen when we consider that, if the purchasing power of money could be increased to its pre-war level, the present national debt would become a burden impossible to bear.

In the period before the war, as the banking system always operated to keep a fairly constant relation between the amount of credit created and the available gold, the general price level was harnessed (but not quite rigidly) to the value of gold. The knowledge of this fact enables us to explain many of the changes in the level of prices during the last century to which we have referred above. At times when fresh supplies of gold became available, the value of gold often fell (as would be expected) and prices rose as a result. When a new demand for gold for currency purposes was made—as when silver was demonetised by a number of countries—the value of gold rose and prices in gold-using countries fell.

During the war unprecedented alterations in the purchasing power of money have occurred, and all the evils of a variable standard of value have appeared to a degree which makes them unmistakable. The rise of prices has been accompanied by a great increase in the volume of the currency. The amount of gold in this country did not increase, but the ratio maintained before the war between the gold and the credit portion of the currency was very greatly decreased. The increased volume of the currency showed itself partly in the amount of paper money (currency notes) and partly in the increase in the amount of the loans by banks (especially the Bank of England). The effects of these changes have been very serious in both their social and their economic effects.

The real trouble lies in the fact that when gold was adopted as currency it was chosen on account of its suitability as a medium of exchange, as was mentioned at the beginning of this article. It has since, however, been required to act also as a standard of value. The rapidly increasing complications of the productive machine and the making of contracts, expressed in money, and covering a period of time, have rendered gold unsuitable to fulfil its function as a standard of value. The evils of the variations in prices consequent upon its continued use have been indicated above.

Professor Irving Fisher points out that we have now defined with the greatest possible minuteness our standards of weight and length and other similar units, but we have left the monetary standard in a most unsatisfactory state of " primitive crudity." The currency unit always represents the same quantity of gold, but it represents a varying quantity of every other commodity. As a measure of purchasing power it reflects all the changes affecting gold, but no other commodity. It is suggested that this should be remedied and that the unit of purchasing power should also be defined, and defined in relation, as far as it is easily possible, to all commodities that are purchased.

The scheme proposed by Professor Irving Fisher depends upon the index number to which we have referred above. As this number indicates variations in the general level of prices, it can be used to correct these variations. When the index number shows that the monetary unit will purchase more than previously, the scheme provides that sufficient gold shall be taken out of the unit to cause its purchasing power to be the same as before. This would not, of course, be practicable if gold coins were in circulation, as was the case before the war. It is, accordingly, proposed that no gold coins be issued, but that the national stock of gold be kept in a central reserve and that gold certificates be issued in exchange for it and circulated as currency. These certificates would always be payable in gold on demand—in the same way as Bank of England Notes were payable in gold at a fixed rate (always 123·2744 grains of standard gold for one pound sterling). The new certificates would be redeemed at a rate published periodically—say every two months—by the Government. If, at the end of two months, the purchasing power of a pound had fallen (i.e. general prices had risen) by 1 per cent., the weight of gold given for a one-pound gold certificate might be increased 1 per cent. At the end of the next two months, if prices had continued to rise, the weight of gold to be given might be again increased. As soon as prices began to fall again the weight of gold to be taken as the equivalent of the pound would be decreased. Just as few people ever trouble to go to the Bank of England now for gold in exchange for Currency or Bank Notes, so at any time the alteration in the weight of gold that *could* be got would probably pass unnoticed by many individuals. While the monetary unit would always represent a varying amount of gold, it would much more nearly represent a constant value in commodities. As most of us wish to exchange money for goods and only the jeweller and a few others wish to exchange it for gold, the system would be much more reasonable from the point of view of the individual.

To the financial and commercial worlds the advantages would be equally great. At times when prices had been rising and the amount of gold to represent one pound had been increased, the store of gold held as national reserve would represent a less number of pounds than before, and if, as before the war, an attempt is made to preserve a constant ratio between the gold reserve and liabilities of bankers, a reduction of liabilities must take place. This would probably be effected by calling in some gold certificates, and thus banks, deprived of some of the legal tender paper, would call in some of their loans in order to balance their own positions. Thus, an increase in the published gold equivalent of the pound would result in the desired reduction in prices by decreasing the amount of currency available to do the money work. A decrease in the published gold equivalent of the pound would operate in exactly the opposite direction. In this way would be avoided most of the difficulties resulting from the "trade cycles" of the last century referred to above, for, in place of the jerky adjustments of the volume of the currency by bankers, the adjustment would be automatic and uninfluenced by the waves of optimism and of pessimism which used alternately to pass over the business world.

The stabilisation of the purchasing power of money would be of inestimable benefit in eliminating the present uncertainty introduced by our money into all relations between buyers and sellers, employers and workers, borrowers and lenders, insurers and insured, and all those classes entering into contracts expressed in terms of money. It should go far to eliminate misdirection of productive power through variations in money prices due to monetary influences. Any standard but an unvarying one involves uncertainty, unfairness, and hardship.

In conclusion, it is fair to say that one of the reasons which hinders the general adoption of the plan is the fact that the stabilisation aimed at is measured by the use of an index number. An index number for the whole world is, at present, an impossibility owing to there being no list of commodities which are purchased everywhere—demands of purchasers vary according to the place and conditions. It is also somewhat widely felt that even local index numbers are unreliable. There can be little doubt, however, that stability according to the best available local index number would be a very great step forward.

The other objection often put forward is that the alterations in the content of the monetary unit are left to the Government, and it is felt that opportunity for "adjustments" is thus given. If the index number were published, as is now the case, such "adjustments" would become obvious, for it would always be possible for the index number to be checked. The present system does not, however, prevent Government action from inflating the currency and depressing its purchasing power—for this was done during the war. During periods of war it is quite possible that the system might break down, but this cannot be lodged as a valid objection to its adoption in times of peace, for it *need* not break down in times of war.

The attempt to stabilise the purchasing power of money is an attempt to substitute exactness and certainty for random variation and uncertainty, and Professor Irving Fisher's scheme provides a reasonable method of doing this, and to him is due the credit for an invention which may prove to be of the most far-reaching importance to the world.

BOOKS

Stabilising the Dollar, by Irving Fisher. (Macmillan.)
The Purchasing Power of Money, by Irving Fisher. (Macmillan.)

Prehistoric "Cup-markings"

The recent announcement in *The Times* of May 31 that Mr. L. M'Clellan Mann, the well-known archæologist, of Glasgow, has discovered a series of "cup-markings" on the surface of a rock at Green Island, Jersey, is of considerable interest in connection with the study of prehistoric man. Cup-markings are of fairly frequent occurrence in this country and on the Continent, and are found in many other parts of the world, including India, Australia, and North America. In form they are shallow depressions cut on rocks or erratic blocks, or on stones which have been adapted and worked by prehistoric man for a purpose such as the construction of a dolmen, or a monolithic monument. They vary in size from one to three inches or more in diameter, and in depth from a half to one and a half inches. The cup-markings found in Jersey are said to be identical with those found in this country, and are described as beautifully carved and perfectly circular. It has been stated erroneously that cup-markings have not hitherto been found in the Channel Islands; but two instances have been recorded from Guernsey, one on the prop-stone of a dolmen, the other on a "standing-stone."

A more complex form of cup-marking also occurs, in which the cup is surrounded by one or more shallow concentric circles. Not infrequently a radial groove runs from the cup or from one of the inner rings to the outer ring or even beyond. Two cups are sometimes found joined by a similar groove. The distribution of the cup-and-ring is somewhat peculiar: it occurs with some frequency in the northern counties of England, being, in fact, more often found than the simple cup, occasionally in the southern counties, in Scotland, and in Ireland; it also occurs in Sweden. Outside these areas, except for a few isolated instances, it does not occur elsewhere in Europe. Outside Europe it has been found in India, North America, Central America, and New Caledonia. A second peculiarity of the cup-and-ring is that in Great Britain it is usually associated with other forms of rock carvings, such as the wheel, the spiral, and sometimes the swastika, while in Sweden, in addition, it is often accompanied by representations of ships, both manned and empty.

Various conjectures have been made as to the object and meaning of these carvings. Their frequent occurrence on the topmost slab or capstone of a dolmen has suggested a sacrificial purpose, i.e. that they were intended to hold offerings or catch the blood of a victim; but the fact that they have been found on upright or slanting stones and rocks seems to preclude this idea. Their lack of arrangement would go to show that they were not intended to be decorative. It is impossible to say more at present than that they probably have a symbolic meaning, although their association with the wheel and swastika has been responsible for the suggestion that they are connected with sun-worship.

Both forms of cup-markings may be dated with a reasonable degree of probability. The frequent occurrence of cup-markings on dolmens and "standing-stones" indicates that they belong to the Late Neolithic or Early Bronze Age. This dating is borne out by the Jersey find. Green Island—which, it may be noted, is an island at high tide only, and has been separated from the mainland in comparatively recent times—is known from previous discoveries to have been the site of a neolithic burial-place. On the other hand, the form of the cup-and-ring suggests a later phase, while the symbols with which it is so frequently associated belong to the Bronze Age. A further indication is its occurrence on slabs used in connection with Bronze Age short cist burials, and on stones situated near such burials or in the neighbourhood of settlements of that date.

The problems of origin and distribution present many points of interest, of which space does not permit the discussion here. In the case of Jersey and Guernsey, it would be natural to look to Brittany as the source. In prehistoric times, and particularly in the Neolithic and Early Bronze Ages, there was close and frequent intercourse between the Channel Islands and Brittany. Sculptures of various forms are of frequent occurrence on the megalithic monuments of the latter area, and among them a number of examples of cup-markings occur. It has been suggested that the cult of a goddess, for which there is evidence in the sculptures on the monuments of Brittany and Guernsey, is to be derived from the Ægean. It is, perhaps, significant that cup-markings have been found in the south of France: at Luchon, in the Pyrenees; in the Department of Lozère, and in the Valley of the Rhone. They also occur in Portugal. These instances all carry back the cup-marking along the line of the dolmen-builders in their movement from the Mediterranean around the coast of the Iberian Peninsula and France to Brittany. On the other hand, it must not be forgotten that cup-markings are of frequent occurrence on the erratic blocks of Switzerland. Further, the late Mr. George Coffey, in tracing the spiral, with which the cup-and-ring mark is so frequently associated, to the Mediterranean, held that it reached Ireland from Scandinavia.

E. N. Fallaize.

Correspondence

To the Editor of DISCOVERY.

SIR,

Will you kindly allow me to make one or two remarks with regard to Mr. J. S. Huxley's review of my book on *Symbiosis, a Socio-Physiological Study of Evolution*, which appeared in the June issue of your esteemed journal?

Mr. Huxley, I am glad to say, has something favourable to say at least about my exposition of Symbiosis as a factor of progressive evolution. But behind the morphological study of Symbiosis (with which many are content) there lies that of the "payability" of Symbiosis. And this very important subject quite inevitably opens up those economic and pathological considerations which loom so largely in my book. On truly co-operative methods, Symbiosis pays well. On any lapse to methods of mutual plunder it pays less well, and the symbiotic relation, and all that it entails, may come to an end ignominiously.

For very good reasons, I hold that the same sequence obtains on the grand scale of Nature; and in this way I explain degeneration and extinction. Mr. Huxley admits that the principle involved in Symbiosis, namely partnership, is the cause of much that is good in evolution. But, like many other biologists, he cannot yet bring himself to realise that, inversely, the opposite principle, namely predacity, is responsible for much that is evil.

I will not ask him to accept my conclusion in a hurry, nor as the necessary corollary of the proposition to which he shows greater readiness to subscribe. I hope in due time to publish such facts as to leave no doubts in the matter. All I would urge for the moment is this, that evolutionary pathology is still rather backward, and that the very important matter of "correlations" has been sadly neglected. Perhaps one should not attempt to do too much in a hurry. But with "correlations" duly focused, I have no doubt Mr. Huxley, and with him a number of broad-minded biologists, will see eye to eye with me much further than they do to-day.

Yours faithfully,
H. REINHEIMER.

THE FAIRY PHOTOGRAPHS

To the Editor of DISCOVERY

SIR,

I notice in the current number of DISCOVERY that the fairy photographs are clever fakes. I should be very glad to know your reasons for this opinion. Mr. Gardner and I have examined this question, know the people concerned and their life history and capabilities, have had the second set of results upon plates marked by ourselves, and have had the results enlarged to their full capacity and examined by several of the greatest experts in England, who could find no sign of any fake.

On the other side is the irresponsible opinion of a young man who has never even taken the trouble to examine the negatives, although it was stated in the article that Mr. Gardner held them for reference.

You are probably aware that the *Westminster Gazette* sent up a very critical Commissioner, who shook our story in no way, and declared that he had no doubt as to the bona-fides of the family concerned. He brought out the fresh fact that it was the first time the girl had ever been allowed to use her father's kodak.

In the face of all this we have a right to ask you what possible precaution we have neglected, and what right you have to brand us as foolish dupes, unless you have some evidence to upset our conclusions.

Yours faithfully,
A. CONAN DOYLE.

[The existence of fairies is something very strange and very new. No one should shout down or think any the less of a man who puts forth a plea for their existence, although to many it appears nonsensical. It may be true or partly true, and even if it be not true an investigation may lead to something important or helpful. Science is not so overburdened with ideas that it can afford to dispense with any. On the other hand, we have the right to adopt a doubting-Thomas attitude towards the alleged new fact. If we can be convinced, as Thomas was, well and good; if not, we may either suspend judgment, or point out where we think the putter-forth of the view has, as we think, erred, or been deceived.

The burden of Mr. Vincent Patrick's remarks which I quoted in the Editorial Notes was that photographic evidence (*a*) may be untrustworthy even when the photographer is perfectly sincere and trustworthy, and (*b*) may easily be faked so that people may be deceived. Because of this, photographic evidence must be secondary. It may confirm; I do not think it can convince. The evidence that is wanted is the assertion by qualified and trustworthy persons (such as the members of a learned society), in normal health, that they have seen the fairies with their own eyes. If this assertion can be made, we need worry neither about photographic evidence nor about the good faith of those who have been concerned in the production or the critical examination of the photographs. Until it can be made, critics have a right, as a matter of interest, to indicate possible ways in which a camera may appear to record things which have not been seen by the eyes.—Editor.]

Reviews of Books

Bibliotheca Chemico-Mathematica. A Catalogue of Works in Many Tongues on Exact and Applied Science. Two Volumes. (Henry Sotheran & Co., 63*s*.)

It may be news to some that there is a demand for old books on science. Not only is the demand a real one, it is one that grows from year to year. I do not think that scientists or students of the history of science will ever take the same interest in old books in their subject as do the enthusiasts who collect first and early editions of works of literature, for the scientist is necessarily too much concerned with the present to care very much about the past. A study of the history of his science must be left to leisure hours, and if there is awakened in him an archæological interest in his subject, such as is evinced by a desire to collect old books about it, it is an interest which is quite separate from, and not part of, his interest in the facts of science.

That a study of old books may be not merely interesting and entertaining but stimulating and helpful also may be very clearly proved by a perusal of this catalogue. So wide an interest does it give a reader in the long and distinguished past of the physical sciences that I have no hesitation in saying it should be in the hands of every lover of the sciences fortunate enough to have the means of possessing it. These two volumes are a bookseller's catalogue. Booksellers' catalogues have often been very beautiful and interesting productions. These books are a very beautiful and interesting production. They are a sale catalogue arranged by authors' names of about seventeen thousand books in Mathematics, Astronomy, Physics, Chemistry, and one or two other subjects. Most of these are old books, but there is also a supplement containing the names of new and up-to-date books. Against each book is given the date of publication and its present price. A description of the book, and in many cases pithy and pawky remarks concerning it, are appended to its name. Many of these notes deal with the historical or archæological interest of the book.

If these volumes were only a catalogue of the usual type, they would be of great interest, but the illustrations make them still more valuable. They are facsimile reproductions of letterpress, title-pages, wood-cuts and diagrams, portraits and photographs, taken from the rarer or more important works. These illustrations, we are told, have been prepared by a photographic process. Their production is singularly beautiful. There are portraits of Newton; Huygens, famous in optics; John Napier of Merchiston, a pioneer of logarithms; Torricelli; Dr. Thomas Young, the discoverer of interference; the Hon. Robert Boyle (he crops up in every historical scientific book); Faraday, Galileo, and Laplace. A page of the first printed edition of Euclid's *Elements* (1482) is reproduced; four illustrations of Daguerre's photographic apparatus from his book (1839); Hevelin's map of the moon (1647); the title-page of an excessively rare work of Kepler, giving the first two of his "three laws" (1609); a drawing of the earliest practical electric telegraph apparatus (invented by Sir Francis Ronalds, 1816); one of Ovenden's "new machine to go without horses," an early forerunner of the bicycle (1774); a page of Huygen's treatise on light, in which the author propounded his theory of "elementary waves" which enabled him to explain the reflexion and refraction of light on the basis of the undulatory theory; the title-page of the first issue of the first edition of one of the greatest works on exact science ever published, Newton's *Principia*.

Let us now look at the description and prices of some of the books themselves. For the best edition of the *Principia* eighteen guineas is asked. It is interesting to note that the cost of the printing of this edition was borne by Halley, the comet man. He edited it also and saw it through the press. Samuel Pepys, the diarist, then, if you please, President of the Royal Society, gave the book the Society's *imprimatur*. The first edition became rare almost immediately after publication, for a copy was procurable, we are told, in 1691 only with great difficulty.

Another book of about the same period, not of quite the same scientific importance, but quainter, was Sir Kenelm Digby's *Of Bodies and of Man's Soul. To Discover the Immortality of Reasonable Souls with Two Discourses of the Powder of Sympathy and of the Vegetation of Plants.*

Digby was an interesting type who first described his "powder of sympathy" in a lecture which was supposed to have been delivered at Montpellier in 1658. The principle on which this "powder" worked was akin to the well-known method of catching a bird by applying salt to its tail. The powder healed a wound not, as you might imagine, by its being applied thereto, but by being kept away from it. The procedure was as follows: A bandage which had encircled the wound was removed from it and immersed in the powder, and *kept there till the wound was healed.* Quite clearly, Digby was an impostor, yet he seemed to have impressed James I and others with its efficiency.

Mr. Sotheran has also a fine copy of the excessively rare original edition of Copernicus' work, *On the Revolution of the Heavenly Bodies.* This work, which, to use the optimistic phrase of the modern publisher, was certainly "epoch-making," was completed in 1530, but not published till the close of the author's life. In 1542 the poor fellow was seized with apoplexy, and next year, just before he died, the first printed copy of his book was brought to him. He looked at it, touched it, and later expired.

Many quaint works are described in this catalogue. There were always plenty of authors, it seems, to rush into print to demonstrate the accomplishments of a successful perpetual-motion device, or to prove that the earth is as flat as your hat. As early as 1532, Robert Valturio published in Paris the details of a cannon for hurling projectiles "round the corner"! This is evidently a lost art! Ovenden's description of the machine which travelled without horses has many quaint touches. This machine was "capable of travelling, with ease, six miles in an hour; and by a particular exertion of the footman, might travel nine or ten miles an hour on a good road, and even would go up a considerable hill." The illustration shows that the master sat in front, while the "footman" (appropriate name!) perspired behind.

This catalogue, indeed, is a joy. Rich in biography of great scientists, it touches lightly and even gaily on the eccentricities of the past, yet rightly calls attention to the really important books and the theories or discoveries which they contain. It is scrupulously well edited, and the illustrations are a perfect marvel of delight.

A. S. R.

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Editorial Notes

THE first duty of the new editor of DISCOVERY is to pay a cordial tribute to the skill and driving-power of his predecessor. Under Dr. Russell's guidance, during the nineteen months since its inauguration, this journal has supplied, with a steadily increasing range of information, a demand for knowledge in the wide field of the Arts and Sciences that has never before been known in this country. His successor is in the happy position of being able to build on firm foundations laid by him and by that group of intellectual men who conceived and put into being the idea of such a journal.

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That DISCOVERY has before it all the opportunities for a high career there is no doubt; there would be no doubt even without the solid success which it has already attained. The present times show many points of resemblance to that sudden revival of learning and that quickening of national and individual imagination which coursed through Europe in the fifteenth and sixteenth centuries. But, whereas that Renaissance was confined only to the more wealthy and powerful classes and the *intellegentsia* of Europe, the spirit of our own age is affecting all classes of our social complex. Signs of this new spirit were not wanting before the war; but, if the war did not create it, it matured its growth in remarkable fashion. It is a restless spirit; it questions the value of existing social and international conditions, and of many ethical and religious doctrines placidly accepted by the Victorian millions; it asks for more definite and accurate knowledge of scientific discoveries, and movements in art, literature, and philosophy than is given to it by the daily Press. It is a spirit which thirsts for education, and whose thirst must be satisfied.

* * * * *

These remarks do not refer to any single class. Bagehot, the economist and historian, writing over sixty years ago, declared that there were not more than 10,000 well-educated persons in Great Britain. What he meant by this statement was that there were not more than 10,000 persons who possessed a sufficient store of knowledge to enable them to think accurately and to think for themselves. If we had to compute the number of present-day educated people by this standard, should we be far wrong in multiplying the above quantity by so small a figure as five? Such a number would by no means be drawn only from the upper and upper middle classes.

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But the truth is that most of us are at least striving to be well-educated. The war had this effect upon us: those of us who were of military age it released to a period of action, of intense emotion, of experiences in foreign countries; those who were not of military age it taught how to take up work of a different nature from that to which they had been accustomed, it gave them a new career and shifted the currents of their lives in middle age, or it left them, in prolonged periods of comparative solitude and of anxiety, to their own thoughts. But all of us had to live or to think beyond the horizons of our offices, our workshops, or our villages; and this has left its mark upon us.

So the time is ripe for the new schemes of national education, for the reforms which are taking place in our public schools and universities, and for the many spontaneous movements, such as the Workers' Educational Association. In this general trend towards a better state of things Discovery hopes to play its part by providing all those who are seeking for it with the first-hand evidence of experts in all the many spheres and developments of knowledge.

* * * * *

I have received some interesting details about the Oxford University Expedition to Spitsbergen.[1] The first party left England on May 31 for Tromso, where it was held up for about three weeks owing to a difficulty over stores. However, it sailed for Spitsbergen well before the end of June in the sloop *Terningen* (specially chartered for the expedition), and the latest news from it (on June 29) was a report that the ice conditions were very favourable and that the explorers hoped to be able to get round to the north of Spitsbergen and visit North-East Land, which is practically unknown. The members of this party are: Rev. F. C. R. Jourdain (leader and ornithologist), Dr. T. G. Longstaff (doctor and ornithologist), Captain R. Pocock (surveyor), Messrs. J. S. Huxley (geologist), C. S. Elton (assistant zoologist), R. W. Segnit (geologist), A. Summerhayes (botanist), Seton Gordon (photographer), H. W. Paget-Wilkes and D. Brown (assistant ornithologists), A. Powell (bird-skinner), and G. Binney (in charge of stores).

* * * * *

The objects of the expedition are to collect zoological (particularly ornithological) and botanical specimens, to collect fossils and carry out general geological work, and to make observations on the breeding habits of birds, especially of the Phaleropes, and on the rate of growth of marine organisms in Arctic waters. It has the use of apparatus kindly lent by the Board of Fisheries and by the Admiralty, with which it will make observations on the variations of temperature and salinity of sea-water, and carry out soundings. This party expected to return by the end of this month.

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The second party left England by a collier boat at the beginning of July. It consisted of Messrs. N. E. Odell (leader and geologist), R. F. Stobart (surveyor), R. Fraser (meteorologist), G. Slater (glaciologist), J. Walton (botanist), and A. M. Carr-Saunders (zoologist). Its plan of campaign was to form a base at the end of Klass Billen Bay, whence a sledging party of four members was to start out with the object of exploring, surveying and making geological observations in New Friesland, while the rest of the party remained at the base to undertake geological, botanical, and zoological collections, and a collection of Vertebrate fossils. This party expected to return by the middle of September.

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It will be seen that the two parties include some brilliant young men in the scientific world. The Rev. F. C. R. Jourdain, the leader of the first party and a considerably older man that most of his companions, is famous for his contributions to the literature of ornithology, and has collected birds all the world over, one of his latest expeditions having taken him to Morocco. Mr. Julian Huxley is well known not only amongst scientific, but much wider circles, for his zoological experiments. He has written articles and reviews for this journal. Mr. A. M. Carr-Saunders, a Demonstrator in Zoology of Oxford University, has made wide researches both in zoology and in biology, and is a member of the Alpine Club. These are only names at random. A member of the party with a somewhat romantic experience is Mr. H. W. Paget-Wilkes. He came up to Oxford in 1919, after being repatriated from Germany, where he had been a prisoner of war since the German offensive in March 1918. An undergraduate up to a few months ago and at present only twenty-two years of age, he conceived the idea of such an expedition and did a great deal of the spadework in its organisation.

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The last British expedition on a large scale to Spitsbergen took place in 1919 under the leadership of Commander Frank Wild, C.B.E. This officer is taking the second-in-command's place in Sir Ernest Shackleton's expedition through Antarctic waters planned to start at the end of this month.

At the instance of the Scottish Syndicate, some extremely interesting investigations of Prince Charles Foreland, the mountainous razor-shaped island off the west coast of West Spitsbergen, and of Stor Fjord, which runs up between Edge Island and the east coast of West Spitsbergen, were carried out last summer by a party under Mr. J. M. Wordie, to whose paper on the country I have already referred.

* * * * *

We are certainly maintaining our reputation as a nation of explorers in polar waters. At the same time we must not overlook the gallantry of Captain Amundsen.[2] In a second attempt to drift with the pack-ice in his ship, the *Maud*, across the Polar Sea via the Bering Strait, he was pinned against the

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[1] For a general description of Spitsbergen, see article by Dr. R. N. Rudmose Brown in Discovery, January 1920; also article by J. M. Wordie in *The Geographical Journal* July 1921

[2] For an appreciation of the difficulties of this undertaking see an article on "Problems of Arctic Discovery," by Dr. R. N. Rudmose Brown, in Discovery, May 1921.

Asiatic shore just north of the Strait by drift-ice last November. But he intends to try his luck again this autumn and expects to be away for a period of five years.

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In this number we publish an article on John Clare, the peasant poet of Northamptonshire, whose work made a great sensation in literary and fashionable circles early in the nineteenth century. His comet-like fame blazed suddenly and died away almost as quickly. Perhaps this is not surprising since he wrote in an age bestarred by a multitude of great poets, including Wordsworth, Coleridge, Byron, Shelley and Keats—an age commonly known as the Romantic Revival, whose zenith lasted from 1798 (the date of the publication of the *Lyrical Ballads* by Wordsworth and Coleridge) till the first appearance of Tennyson in 1830. But Clare, with his delicately expressed and minutely observant nature poetry, and with his restless verses produced by an early unfulfilled love, made a definite contribution to literature. It is not to be wondered at that revived interest is being taken in his work during a period such as ours, when both poetry and fiction are confining themselves to accurate observation of nature and humanity, and to the technique of literary expression rather than to the higher flights of imagination.

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The writer of the article, Mr. Edmund Blunden, is himself a young nature poet, whose volume, *The Waggoner and Other Poems* (Sidgwick & Jackson, Ltd., 1920), has attracted a great amount of attention. I quote the concluding lines of his poem, "Clare's Ghost," written in a smithy in 1917:

> " And a stranger stands with me here in the glow
> Chinked through the door, and marks
> The sparks
> Perish in whirlpool wind, and if I go
> To the delta of cypress, where the glebe gate cries,
> I see him there, with his streaming hair,
> And his eyes
> Piercing beyond our human firmament,
> Lit with a burning deathless discontent."

* * * * *

A few words about some of our contemporaries. In the July number of the *Scientific American Monthly*, Professor Eisenhart lucidly explains Einstein's theory of the universe as "unbounded but of finite volume," while Mr. Snowden Sinclair emphasises the hazardousness of the Mount Everest Expedition. On this latter subject *The Geographical Journal* for July gives some interesting notes. *The Nation and the Athenæum*, in its issues of July 9 and 16, considers British soldiers' prose accounts of the war. The time has arrived for a critical estimate. We intend to give one in an early subsequent number.

(*a*) Old Paintings and Polarised Light

How Ancient Paintings, Dark with Age and Patina, can be viewed in all their Pristine Freshness, without Restoration—A Parisian Scientist's Discovery

By George Frederic Lees

TIME is sometimes credited among connoisseurs with having added to the beauty of oil paintings by the Great Masters. The pigments and mediums, with which they were painted, darken in the course of centuries, largely owing to the action of light and atmospheric conditions upon them. Some of these works of art take on a patina, which is often said to enhance their beauty and value. But are we quite certain that this is so? Which would you prefer: a painting by, say, Raphael just as it is to-day, or the same work exactly as it was when the Master put the finishing touches to it, when it appeared in all its pristine freshness? The majority of people would, I believe, vote in favour of the masterpiece as it appeared to the eyes of the painter and his contemporaries, and would regret that it is no longer possible to see the work as it was in its original state.

Are we quite certain, however, that it is impossible to do this? Cannot science help us to see through the dust and incrustations with which ancient pictures are covered, and to behold the colours as they left the artist's brush? . . . These were questions which a Parisian scientist, M. Pierre Lambert, asked himself in the course of experiments at the Sorbonne; and whilst seeking for one discovery he unexpectedly made another which has permitted him to answer those questions in the affirmative. The members of the Academy of Science, headed by M. Lippmann, have just witnessed these experiments in M. Lambert's laboratory, and one and all were very much impressed.

A picture may be regarded as made up of two parts. There is the paint forming the picture itself, and there is the varnish covering the brushwork. Now the light reflected by the picture is reflected not only from the painting itself, but also from the varnish. If the latter be perfectly flat and polished, and if the observer place himself in a good position he may see the picture properly. But the surface of an old picture is generally irregular, full of little hills and dales, and even under the most favourable conditions of lighting the light reflected by the surface usually interferes in a remarkable manner with the reflection from the painting itself. It is therefore impossible to place oneself completely out of the reach of the reflections from this irregular surface which interfere so greatly with the effect expressed by the painter. If, therefore, a method could be devised by which the person viewing the picture could see it without his view being interfered with by this surface-effect, it would enable the person to see the picture as it was when it was first painted or as it would be if it were properly restored. By means of his polarised-light apparatus M. Lambert has made this possible.

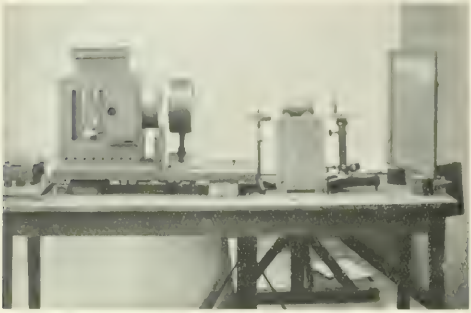
FIG. 1.—THE APPARATUS USED FOR PROJECTING POLARISED LIGHT ON TO OLD PICTURES.

A word now on polarised light. Ordinary light, such as sunlight or electric light, consists of transverse vibrations, the vibrations taking place in all directions at right angles to the direction of the rays. There are certain bodies, however, such that when light is passed through them the transverse vibrations all take place parallel to one definite direction only. The ray of light is then said to be *plane-polarised*.

The usual means of obtaining plane-polarised light is by means of a prism called a Nicol's-prism, which is made from a crystal of Iceland Spar (calcium carbonate). A Nicol's-prism may be used not only for producing polarised light (when it is called a polariser), but also for determining the plane in which the light is polarised, when it is said to be used as an analyser.

Let us consider the Nicol's-prism as an analyser. If the light falling on the Nicol be *unpolarised*, the intensity of the light which will get through will remain the same when the prism is rotated round the light ray as axis. If the light be polarised, however, the intensity of the light varies from a maximum to zero as the analyser is rotated. It is not hard to understand, therefore, that if a mixture of polarised and unpolarised light fall on the analysing prism, it is not a matter of difficulty to rotate it so that the unpolarised light alone gets through—i.e. if the eye looks through the prism, only the unpolarised light is seen by the observer. When the analysing Nicol is so rotated that none of the polarised light gets through, it is said to be in the position of extinction. But, of course, even in the position of extinction the unpolarised light passes through the Nicol's-prism and is seen by the observer. It is these facts which are made use of by M. Lambert.

His method is to light up the picture under examination by polarised light and then to examine it through a Nicol's-prism. Under these conditions the light reflected by the surface, being for the most part polarised, is extinguished by the Nicol's-prism when it is held in the position of extinction, whilst the light passing through the varnish is depolarised by diffusion on the surface of the matter composing the colours and, being unpolarised, reaches the eye through the prism. In this way an observer sees the painting itself.

The apparatus consists of a source of intense light, an arc or incandescent lamp with a low voltage. This light is enclosed in a lantern, provided with a condenser, followed by a lens destined to make the rays parallel during their passage through the polarising apparatus (a Nicol's-prism). A diverging lens then enlarges the pencil of luminous rays and lights up the entire picture, the plane of which is almost normal to the axis.

" Although this position is very disadvantageous under ordinary conditions," the inventor has explained. " the observer, looking through the Nicol's-prism, is able by slightly turning the instrument in his hand to find a position in which the superficial reflections are completely suppressed. In this way, as you will see, an old and dull-looking picture becomes perfectly distinct and full of vigour ; its surface appears to have been restored ; colours become more intense, and details which do not attract the attention seem to assume the value they had when the work was painted."

The first picture to be submitted to the action of polarised light and then viewed through the Nicol's-prism by one member of the Academy after the other was an old portrait of Gabrielle d'Estrées, a work con-

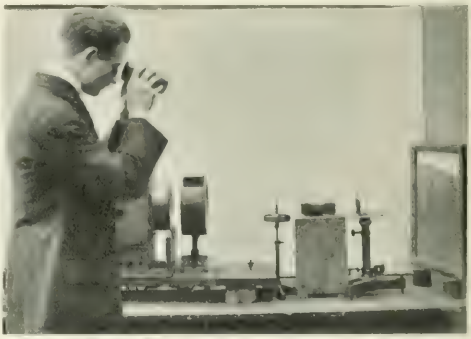
FIG. 2. POSITION OF THE OBSERVER WHEN LOOKING AT AN OLD PICTURE THROUGH A NICOL'S PRISM.

temporary with that fair lady and therefore black with age. All that could be distinguished on this little medallion portrait were the faint outlines of a woman's head and bust, slightly *décolletée*. Here and there were faint outlines of things which the artist had carefully drawn and coloured—details so obscured by Time that one could hardly tell what they represented. But once the canvas was set up, flooded with light in the darkened laboratory, and viewed through the prism, everything down to the slightest particular and touch of colour was restored to pristine freshness. The writer was able to count the jewels in a magnificent ornament at the lady's waist; he could see every lock of her hair, almost every hair of the pretty curl which caressed her bosom; her eyes became as living to him as they were to her contemporaries.

An old picture of a bouquet of flowers was transformed in a similarly marvellous manner. This particular work was in so advanced a stage of obliteration that the flowers seemed to be suspended in mid air above a table. But on being illuminated and viewed through the Nicol's-prism everything sprang into being, with all the freshness of colour given to the still-life subject on the day it left the painter's studio. The flowers—roses, honeysuckle, and other species all easily distinguishable—were seen to be in a dark green glass bowl, partly filled with water, the transparency of which was really admirably depicted.

A number of landscapes were next examined, and in each case they appeared to the eye as though they had just passed through the hands of an expert restorer.

"What an admirable aid to the restorer of works of art!" was the reflection made by more than one of M. Pierre Lambert's guests. And someone voiced the thought.

"Yes," replied the physicist, with his customary modesty. "But for that I should not have taken the liberty of troubling you to see the application of a phenomenon which is well-known to us. It does seem to me that this method may be of use to connoisseurs who wish to judge of the artistic value of old paintings and to determine whether a given work is susceptible of being improved by modifying its varnish."

Let me say, in conclusion, that M. Lambert has invented an accessory to his lantern—a V-shaped Nicol's-prism binocular—which advantageously replaces the single tube prism, since it dispenses with any turning of the prisms to the "position of extinction," whilst the arms can be placed at angles to suit all eyes.

Vitamines. Essential Food Factors. By DR. BENJAMIN HARROW. (Routledge, 10*s.* 6*d.*)

An exposition for the general reader by a well-known American writer on physiological chemistry.

(*b*) Studying the Human Machine

By George Frederic Lees

THE first moving platform for the study of the mechanism of the human body when walking was made in the United States by Benedict. Very excellent work was done with it, and it certainly put scientists on the track of a new branch of physiology. But this platform only permitted a study of walking on the flat and at speeds not exceeding five miles per hour. Manifestly this was but the beginning. One is not surprised to hear, therefore, that a French professor has made many improvements on Benedict's apparatus and, thanks to the perfected apparatus, has come to many interesting and absolutely new conclusions regarding the working of the human machine.

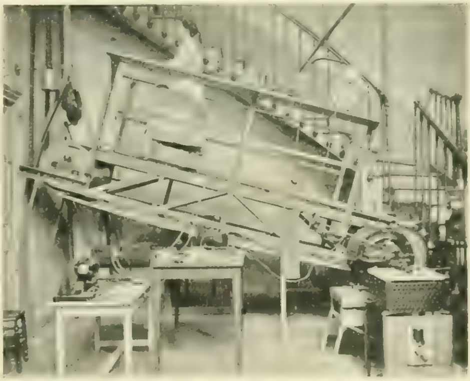
FIG. 1.—THE LANGLOIS MOVING PLATFORM, WHICH CAN BE GIVEN AS GREAT A SLOPE AS 35° AND MADE TO TRAVEL AS FAST AS 18 MILES PER HOUR. IT IS HERE REPRESENTED AT A SLOPE OF 25°

This new moving platform is the invention of Professor Langlois, a member of the Academy of Medicine and professor at the Conservatoire Nationale des Arts et Métiers; it is to be seen in his laboratory at the Faculty of Medicine in Paris; and, as has just been explained to the members of the Academy of Sciences, it is possible to obtain a speed of 18 miles and to study with it the physiological effects produced on a person walking up or descending slopes varying from 5 to 35 degrees. The man when walking or running on the carpet can be studied by means of appropriate registering apparatus, connected by means of rubber tubes to his body, whilst he is at work. Thus the physiological reactions when walking, running, carrying weights, pushing or pulling a wheelbarrow up the sloping platform, etc., can be accurately measured, the ultimate object being to discover the most economical way the human machine can do a given piece of work. The apparatus for registering the temperature, arterial pressure, and psychical reactions of the person under experiment are on tables beneath the platform.

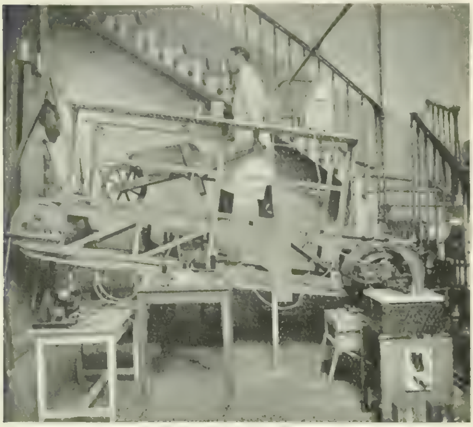
FIG. 2. TESTING THE ENERGY AND RESISTANCE OF A MAN WHEELING A BARROW UPHILL AT A GIVEN SPEED.

It is with this new moving platform that Professor Langlois, working in collaboration with MM. Chailley-Bert and Faillié, has explained the phenomenon known among runners and athletes as "second wind." This phenomenon, which consists in the disappearance of breathlessness some time after a rapid start, gave place to various interpretations by physiologists. In the opinion of Lagrange the disappearance of a runner's uneasiness in breathing was due to a better utilisation of his lungs; whilst others decided that it was owing to a modification of the sensibility of the bulbar centres. Experiments with the moving platform at the Faculty of Medicine have now proved that "second wind" is connected with a real and momentary diminution of the expenditure of energy, although the amount of work done is not diminished. It is due to a better adaptation of the locomotor apparatus of the human machine.

Maps: Their History, Characteristics and Uses. By SIR HERBERT GEORGE FORDHAM. (Cambridge University Press, 7*s.* 6*d.*)

The Mneme. By RICHARD SEMON. (George Allen & Unwin, Ltd., 18*s.*)

Simple Lessons on the Weather. For School use and General Reading. By E. STENHOUSE, B.Sc. (Methuen, 4*s.*)

The Return of John Clare,

The Northamptonshire Peasant Poet

By Edmund Blunden, M.C.

THERE was born at Helpston, near Peterborough, in 1793, a peasant's son who was destined to live to the allotted span through strange and sometimes bitter vicissitudes, and whose name was to suffer after his death changes of reputation hardly less surprising. The life-story of John Clare is not now as unfamiliar as it was twenty years ago, but it will be well to epitomise it once again here, with the benefit of materials discovered within the last few weeks, before we consider the nature of his achievement, the manuscripts which he has left behind, and the romance of his return to fame.

Those who pass through the Dutch scenery and straggling cottages of Helpston cannot but notice an ugly early English memorial at the cross-roads, inscribed with lines of verse by John Clare, and usually ornamented with barrel-hoops which the village children throw like quoits over it. If curiosity enquire further, there is scarcely a soul in the place but will know something of "Poet Clare," and will point out the cottage of his birth, now marked with a modest tablet. The cottage is in the main the same as when the child Clare, already a dreamer, set out with his father's dinner and on voyages of discovery—once he attempted to reach the horizon—towards 1800. Clare's father, a day-labourer, was a believer in education, and the little boy shared his faith, so that by his thirteenth year he had read every book in his schoolmaster's library, and was in a fair way to become a master of copperplate, of land surveying, and other sciences then fashionable at schools. Earlier still, John Clare had learnt old ballads on the cow-common, which were another sort of education; and so, his exercise-books contain his first scribbled verses. With a faithful friend the boy began to hunt and collect old books, and his distaste for football was a source of anxiety to the neighbours. There are two other schoolday episodes which we must mark: his fit of terror at seeing a labourer fall from a haycart and break his neck, the after-effects of which sight were not easily disposed of; and his companionship with Mary Joyce. In this companionship began that unfulfilled love which was to dominate Clare for almost every day and every poem of his long and troubled life.

We must hasten over the vain attempts of Clare, on leaving school, to become a lawyer's clerk and to avoid becoming a drudge. Next door was an inn, still standing, called the "Blue Bell," where he worked for a year under a gentle master. He was next apprenticed in the gardens of Burghley; escaped from the brutalities of his elders to a nursery-garden at Newark-upon-Trent; ran away home, was drawn into the militia that proposed to drive out invading Napoleon, and after a few weeks of organised yahooism was relieved to find himself disbanded. He was now twenty, could write verses and play the violin, had lost his heart (or head) once or twice, and earned his living as comfortably as he could. At twenty-four, he was one day on his way from the lodging-house, where he and other lime-burners lodged, to the "Flower Pot" at Tickencote, when he met his wife-to-be, Patty Turner. Almost at the same time, to meet a debt, he launched a prospectus for publishing *Original Trifles on Miscellaneous Subjects, Religious and Moral*. In the course of a few weeks he had deeply offended Patty, and also lost his work by reason of his distributing the prospectus when he should have been burning lime. The only future seemed to lie in the industrial revival in Yorkshire or the artillery; but luck turned, and his prospectus came to the notice of John Taylor, who was publishing the poems of Keats.

In brief, Taylor produced Clare's first book in January 1820, and the metropolis recognised, if not a new poet, at least a new lion. By the end of March the book was in its fourth edition, and Clare had visited town to find a song of his being sung at Covent Garden by Vestris herself, and admiration at every turn. He returns to Helpston, marries Patty, and is provided by his patrons with an income of, at first, £45 a year.

The story now takes its obvious course. Fashion speedily wearies, and the glare of fame fades from Clare year by year, though he writes finer poetry and makes friends with Lamb, Hood, and other men of genius. Other friends disappoint him; "I mistook," he says in 1829, "*Collins' Ready Reckoner* for *A Treatise on Friendship*." His family grows apace, and illness comes to breed debt and despair. In 1832 he leaves his old home for a farmhouse in the village of Northborough, increasing his physical comfort and his mental discomfort at once; in 1832, he sees once again—and I believe for the last time—his guardian spirit, "a beautiful presence, a woman deity." "The first dream in which she appeared to me was when I had not written a line." Meanwhile, Clare is slaving as cottage-farmer and fighting with mental overstrain.

His last and best book, the *Rural Muse*, was published in 1835; it failed. He grew more melancholy and solitary, puzzled folks more with his strange imaginations, until he was judged out of his mind. He was sent to a private asylum near Epping. Four years afterwards, in July 1841, he broke away and reached home on foot after a terrible journey. His courage availed him little; his insanity was certified "after years addicted to poetical prosings," and on December 29, 1841, he was finally shut up in the county asylum at Northampton.

The record of the last twenty-two years is one of "deep melancholy" (not unintelligible), of constant meditation and poetry, of kindly but uncomprehending interest from those about him, and of conversations with the spirit of Mary—"and every song I write has some sighs and wishes in ink for Mary." He still mystified his acquaintances with his deliberate hallucinations, and with his pipe, a pencil, and paper could always be "miserably happy." At last he waited calmly for death, saying often, "I have lived too long" and "I want to go home"; and when death came, it was in a sleep that he found freedom after so many years.

Clare died on May 20, 1864, and a few memoirs reminded magazine readers of the curious enthusiasm of 1820 for the Northamptonshire Peasant Poet. Oblivion had veiled him, more surely than asylum walls, for so long that these memoirs seemed only the last words of a weary tale. But in the following year there appeared a biography of the poet by his ardent admirer Frederick Martin, Carlyle's secretary, which aroused attention. Martin, however, was afflicted with an exuberant fancy, and his work, for all its enthusiasm, is better described as a novel. The book had a moderate sale; then nine years afterwards a Northampton journalist named Cherry produced a *Life and Remains*, which was included in the Chandos Classics. Cherry brought the gift of caution to his work, exercising it too zealously in his choice of Clare's Asylum Poems, though not in revising their text. His book had its audience; but apathy reasserted itself, and Clare seemed doomed to a line in literary histories and a niche among literary curiosities. 1908 found him practically unknown and unregarded, when Mr. Arthur Symons put forth his volume of selections, with an introduction of careless biography blended with subtle and delightful criticism.

Mr. Symons had had the good luck to come upon two volumes of poems in John Clare's handwriting, from one of which he selected several sonnets and longer pieces of great beauty. He at the same time regretted that he had not discovered the Asylum manuscripts. These two facts induced Mr. Alan Porter and the present writer to take up a fresh search; and, not unnaturally, they discovered that there existed at Peterborough a large collection of Clare's miscellaneous papers. These yielded a rich harvest. It is sufficient to say that they include a volume known as the *Midsummer Cushion*, which comprises the prime of Clare's poetry before 1835; a folio bound in vellum containing many poems of various dates and in special certain lyrics written in the manner of the Elizabethan poets; and two or three volumes of old letters, prescriptions, bills, and the like cobbled up by Clare in covers of wall-paper (an anticipation of a modern fashion). These ragged relics on closer inspection proved of great value, being covered with poetry in various directions and in Clare's most private handwriting, but poetry that fully rewarded the labours of the salvage. The Asylum manuscripts did not take shape, but a transcript of some hundreds of poems came to light and was itself transcribed. From these and certain other materials, as well as from what had previously been printed by or about the poet, a volume entitled *John Clare: Poems chiefly from Manuscript* was produced last year. Here was a poet, not unknown to many critics and readers, who died not sixty years since; and yet it was possible to present his life and his work in such a manner that John Clare seemed an actual discovery. The adventure, if such it may be considered, is not yet ended. The 1920 volume, had the stress of practical publishing been less cramping, could have been twice or thrice as large without monotony or dilution; and masses of new material have emerged later, notably the collection purchased so valiantly (and withal so wisely) by the Northampton Library. It is earnestly hoped that the whole of Clare's work, apart from what he himself suppressed or never intended for publication, may form a definitive edition, and the preliminary labours have advanced steadily; while, carefully as was the brief memoir in the last volume prepared, there are now in my hands fresh facts and impressions enough to make some reconstruction worth while.

In conclusion, let us attempt to sum up the poetry of Clare and the chief literature about him. He is, indeed, first and foremost a nature poet. A naturalist,[1] who is also one of the finest of recent judges of poetry, even claims that he is England's only nature poet; and this, to my mind, is no exaggeration. He observes, he sympathises with, he glorifies, and how deeply he loves "every mood and tone" of nature; the drama is of God's own writing, he dare not miss a syllable or gesture. The eternity and harmony, the architecture and mystery and calm are for ever in his mind, whether he be staring

> O'er the disordered scenes of woods and fields,
> Ploughed lands, thin travelled with half-hungry sheep,
> Pastures tracked deep with cows,
> Where small birds seek for seed,

or on

> The little bees with coal black faces
> Gathering sweets from little flowers like stars.

Other poets love nature, yet their passion is but dim by his; they come with pride, and he as a mortal wooing a goddess.

> And I love all the things
> Her bright eyes look upon.

He is not only the poet of nature; there is another mysticism in him, which gives us such poems as "The Invitation to Eternity," sombre and strange, or the noble spirit-kindling "Love Lives beyond the Tomb."

On his weaknesses as a poet I will not dwell: the chief is his failure to realise that a single poem depends as much on the development as on the richness of its materials. Hence, he rarely achieves perfection in any enterprise of length. But his lyrical gift often brings from words as divine a music as I know.

I add the briefest bibliography of Clare:—

1. *Poems descriptive of Rural Life and Scenery* . . 1820
2. *The Village Minstrel* [in two volumes] . . . 1821
3. *The Shepherd's Calendar* 1827
4. *The Rural Muse* 1835
5. *Life:* by Frederick Martin 1865
6. *Life and Remains:* by J. L. Cherry . . . 1873
7. *Poems:* with memoir by Norman Gale. Rugby: G. E. Over 1901
8. *Poems:* with introduction by Arthur Symons. Oxford University Press. 1908
9. *Poems chiefly from Manuscript:* selected and edited by Edmund Blunden and Alan Porter; with memoir. London: Cobden-Sanderson 1920

Chemical Elements and Isotopes

By A. S. Russell, D.Sc.

Student of Christ Church, Oxford

In a previous article[2] I gave a short description of present theories of the structure of the atom. The chief points of that article may be summarised as follows:

1. Each element is composed of atoms all of which are exactly similar.

2. The atoms of different elements possess the same kind of structure, differing merely in detail.

3. The structure of the atom is supposed to be this. At the centre of the atom is a tiny core of positive electricity called the nucleus. The nucleus may contain both positive and negative electricity, but the former is greatly in excess. It contains approximately the whole of the mass of the atom. Surrounding

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[1] Mr. H. J. Massingham.

[2] DISCOVERY, Vol. 1, p. 301.

the nucleus like planets round the sun are electrons, which are single charges of negative electricity and are of negligible mass. The number of electrons is exactly the same as the net number of positive charges on the nucleus. This number is called the Atomic Number.

4. Each chemical element has one atomic number only. With each atomic number one element only is associated. Hydrogen, whose atom is the lightest known, has the atomic number 1; uranium, whose atom is the heaviest known, has the atomic number 92. Consequently there can be only 92 different chemical elements in existence. Of these five alone remain to be discovered.

In this article I propose to deal more particularly with groups of chemical elements which are called *isotopes*[1] and to explain how the experimental work which led to the discovery of these bodies and the theoretical ideas which have been put forward to fit them into the existing scheme of things have led to a remarkable simplification in our knowledge of what the chemical elements are.

At the present moment we define elements as substances which cannot be decomposed into simpler substances by any chemical process. Nobody ever denies that *theoretically* further decomposition is possible, but nobody has ever met anyone who has effected the decomposition, so there the matter ends. Because the element could not be resolved further chemically it was quite natural for chemists to conclude that the reason for this was that all the atoms composing the element were exactly similar, for if they were not some ingenious investigator would probably have discovered the fact, and worked out a method of separation based upon it. Yet although chemical elements still cannot be decomposed by chemical means into simpler substances it is not a fact that the atoms composing a chemical element are necessarily all the same. From two independent lines of investigation, namely, the study of radio-activity and what is called positive-ray analysis, we now know that a great many (probably, when the work now in progress is completed, the majority) of the chemical elements are really mixtures of two, three, and sometimes more than three elements.

The mixture of elements which comprise one of these elements is, as far as we know, uniform in composition all over the world, wherever it be found or however it be prepared. The constituents cannot be separated one from another by any ordinary process, because they have extraordinarily similar chemical properties. They differ in two important physical properties—in their atomic weights (and properties depending upon atomic weight) and (such as possess it) in their radio-activity. In the remainder of their physical properties, for instance, in their arc-spectra, their X-ray spectra, their potentials, their boiling-points, freezing-points, etc., they are extraordinarily identical. It is because of these two differences that the separate existence of these very similar elements has been established, for otherwise it would not have occurred to anyone to suspect that what appeared simple was in reality complex. These similar elements are called isotopes.

An account of the element chlorine may help to make the above clearer. Chlorine is a substance easily isolated and purified, and of an undeniable elementary character. Its atomic weight has been often accurately determined, and has been found to be 35·46. Yet chlorine is a mixture of two elements whose similarity in every chemical and physical property except that of atomic weight is an identical one. The atomic weight of one is 35, of the other 37, and what we call chlorine is a mixture of uniform composition of these two elements in the ratio of approximately 4 to 1.

Note that these two elements which together compose the element as we know it are elements in every sense of the word. There is no need to coin a word like sub-element, for that word would suggest that they were merely parts of an element. Note also that the element as we know it is not a compound but merely a mixture of the two elements. *It* also is an element, since by definition it is a substance which cannot be split up into simpler substances.

The history of these very similar chemical elements, or isotopes as they are now called, is not without interest. They were discovered by chemists in carrying out research in radio-activity, but at the present time the chief work on the subject is being done by physicists. In 1906 Professor Boltwood of Yale noticed that an element discovered by him and named ionium was similar in its chemical properties to the element thorium. These were quite separate and distinct elements, of course, but he found that if compounds of these two elements got mixed in the course of his work the two kept together, and did not allow themselves to be separated by any chemical process he had occasion to put them through. There is nothing very remarkable in this fact, for there are several groups of elements which are well known to be separable only by a long and tedious process. Copper is easily separated from iron. Iron is less easily separated from aluminium. Neodymium is difficultly separable from præsodymium, and the separation of other members of what are called the rare earths from one another is a matter of greater difficulty still. The question now arises: Is the separation of ionium from thorium just about as difficult as some of these rare-earth separations, or is it very much more difficult? Boltwood did not pursue the subject. He had other work in hand, more interesting, and at the time more important, namely, the experimental proof that his element ionium was the parent substance of the element radium.

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[1] So called because in the periodic system of classification of elements they occupy the same place. (Greek, ἴσος, same, τόπος, place.) They are defined later.

Three years later the work was taken up by two Germans working in Berlin, Professor Marckwald and Dr. Keetman. The interest of these men was primarily in analytical chemical work. Like Boltwood they found ionium and thorium very similar in their chemical properties, but they concluded, after two years' fruitless attempt to concentrate one even in the least degree in a mixture of both, that ionium and thorium not merely resemble one another in a remarkable way, but do not in fact differ at all in any of their chemical properties. This was a remarkable conclusion, and the point now arises: Is this really so, or simply a confession of failure? It has not seldom happened that one man, in attempting to separate two of the difficultly separable rare-earths, has failed, while another attempting the same problem has succeeded. Might not this apply here. The answer is "No." Every conceivable chemical method was tried by these two experts. To detect the slightest change they had an instrument which was many thousands of times more sensitive than any used by those who worked on the rare-earths, yet change there was none. This was a most important result, and Marckwald must be regarded as the pioneer in this work on isotopes.

Shortly afterwards Dr. Hahn, another worker in Berlin, showed that an element mesothorium discovered by him had identical chemical properties with radium, and also that radiothorium, another of his discoveries, was identical chemically with both thorium and ionium. Now thorium has an atomic weight of 232, radiothorium of 228, ionium of 230; their radio-active properties are very different, yet their chemical properties are identical!

The next move forward was in 1912, when a research student in Professor Rutherford's laboratory in Manchester put forward the theory that these chemically similar elements (non-separable elements as they were then called) were identical also in physical properties. This was a somewhat revolutionary view at the time, for though it may be very well to talk about bodies being similar chemically, to say that two different elements have, for example, the very same spectrum was a speculation that required proof from more than one source before it could be seriously entertained. It is well known that the spectrum of an element is a very characteristic property. Several elements have been discovered by means of their spectra. The presence of one per cent. of an impurity in a preparation is easily detected by means of its spectrum. If you can show, therefore, that two bodies have the same spectrum, you are demonstrating that two bodies which *appear to be* identical from their chemical properties are in reality identical. Yet it was found at Manchester that thorium and ionium in a preparation containing as much as twenty-five per cent. of the latter had *identical* spectra. This result has since been confirmed by other workers and is now established.

This work on isotopes was not only interesting in itself. It led to a great simplification in our knowledge of the chemistry of the radio-active elements. One of the most important discoveries in Inorganic Chemistry in the nineteenth century was the classification of the elements known as the Periodic System. This classification has been described in one of the early articles in this journal.[1] The radio-active elements number about forty, but the places in the periodic system into which they must fit, unless they are to be classed as exceptional, number but twelve. Now the periodic system is too true a representation of facts to be lightly set aside; also experimental work has shown that these elements are not exceptional. A difficulty thus arises. How is it to be met? At first this problem was not faced. Workers in radio-activity were so engrossed in investigating the radio-active properties of these curious and interesting substances that an investigation of their chemical properties seemed irrelevant. The substances existed in such microscopic amounts, the most of them, that the early workers were not sure whether these bodies could be said to have chemical properties in the ordinary sense at all. Nor did they care. Any slap-dash method of separating them from minerals or from preparations was considered by them sufficiently good so long as enough was obtained for the work on radio-activity to go on. In time it was shown, however, that radio-active substances form compounds, and possess chemical properties similar to those of the common elements, and also that these chemical properties can be determined more quickly and even more accurately than those of ordinary bodies. When a complete investigation of the chemical properties of the whole of the radio-active elements was undertaken and completed it was found that they fell into ten groups, the members of each group having identical chemical properties. For these ten groups there were twelve places in the periodic system waiting vacant, so that there was more than enough. The hypothesis of isotopes has made it possible, therefore, to fit in the forty radio-active elements into the ten or twelve vacant places of the periodic system, and in this way the difficulty stated above has been obviated.

In illustration of the above let us consider the element lead. Lead has an atomic weight of 207·2; its atomic number is 82; it is not radio-active. It has at least seven isotopic elements. These have the same atomic number as lead, namely 82, exactly the same chemical properties, and, with the exception of atomic weight and radio-active properties, the same physical properties. The names of these elements, their radio-active properties, and their atomic weight are given in Table I.

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[1] C. G. Darwin, DISCOVERY, vol. i, p. 41.

TABLE I

Element.	Nature of Radio-activity.	Atomic Weight.
Lead . .	None	207·2
Radium B .	Expels β-particles	214·0
Radium D .	Expels β-particles	210 0
Radium G .	None	206·0
Thorium B .	Expels β-particles	212·0
Thorium D .	None	208·0
Actinium B .	Expels β-particles	210·0
Actinium D .	None	206 0

One may prepare almost pure thorium D in quantity by working up a mineral containing thorium and no uranium, and pure radium G from a mineral containing uranium and no thorium. Each of these substances will seem to be the ordinary element lead in appearance, spectrum, boiling and freezing points, electric conductivity, chemical properties, etc., yet one has an atomic weight of two units greater than the other, and each has one unit different from that of lead.[1]

Since the conclusion of the war experimental work on isotopes has been mainly confined to the lighter elements. It has been very successful and it is still in progress. The method of investigation is one worked out originally by Sir J. J. Thomson, developed by Dr. F. W. Aston, and known as positive-ray analysis. The essentials of this method are to generate positive rays (which are positively-charged atoms and molecules of a gas) in a partially evacuated discharge tube, and then by means of combined electric and magnetic forces to bring these rays to a kind of focus on a photographic plate. If this be done with oxygen gas one line only appears on the plate, and the deduction from that is that oxygen is a single element and not a mixture of two or more isotopes. If chlorine be investigated in a similar way two lines appear on the photographic plate, one four or five times more intense than the other. The interpretation of this is that chlorine is a mixture of two isotopes in a ratio of approximately 4 to 1, and from the position of the lines it may be further deduced that the atomic weights of these are exactly 35 and 37. Helium, carbon, nitrogen, phosphorus, sulphur, and others are shown by the same method to be "perfectly pure" elements, that is to say, not mixtures of isotopes. Lithium, neon, silicon, argon, bromine, on the other hand, are "mixed" elements. Like chlorine each has two isotopes. The rare gas xenon which is found in the atmosphere has five and possibly seven isotopes, and krypton, another rare gas, has certainly six.

In Table II is given a complete list of the elements which Dr. Aston has investigated so far, with their atomic weights and numbers, their isotopes and their atomic weights.

TABLE II

Element.	Atomic Number.	Atomic Weight.	Number of Isotopes.	Atomic Weights of Isotopes in order of intensity.
Hydrogen	1	1·008	1	1·008
Helium .	2	3·99	1	4
Lithium .	3	6·94	2	6, 7
Boron .	5	10·9	2	11, 10
Carbon .	6	12·00	1	12
Nitrogen .	7	14·01	1	14
Oxygen	8	16·00	1	16
Fluorine . .	9	19·00	1	19
Neon .	10	20·20	2	20, 22
Silicon .	14	28·3	2	28, 29
Phosphorus	15	31·04	1	31
Sulphur .	16	32·06	1	32
Chlorine .	17	35·46	2	35, 37
Argon .	18	39·88	2	40, 36
Nickel .	28	58·68	2	58, 60
Arsenic .	33	74·96	1	75
Bromine .	35	79·92	2	79, 81
Krypton	36	82·92	6	84, 86, 82, 83, 80, 78
Iodine .	53	126·92	1	127
Xenon .	54	130·2	5	129, 132, 131, 134, 136
Mercury .	80	200·60	about 6	197–200, 202, 204

This table summarises effectively the present state of knowledge on this subject. Attention may be called to two things. The first is that in every case but one the atomic weights of isotopes are whole numbers, not merely approximately but accurately so. This fact suggests at once that those elements in nature whose atomic weights are not whole numbers, nickel, for example, are really mixtures of isotopes. 58·68 is a fraction not because that is accurately the atomic weight of a particular element, but because that element consists of two separate and distinct elements, of atomic weights (accurately) 58 and 60 respectively, mixed in such a proportion that the mean value of the atomic weight happens to be 58·68; so for the others. In every case so far investigated (again with the exception of hydrogen) this has proved to be true, and the probability that it holds throughout is very great. The second is a hypothesis which receives a large measure of probability from the above. It is that all the chemical elements are built up of different quantities of the same elementary stuff or stuffs. These are believed to be the elements hydrogen and helium. Whether this hypothesis be true or not is a matter for the future. The experimental attack on the problem has but recently begun.

In closing, one may point out how theories about the chemical elements have alternated between simplicity and complexity in the last hundred years. When the atomic theory was established at the beginning of the last century and the atomic weights of some of the elements determined, a chemist called Prout saw simplicity in everything. The atomic weights were all whole numbers, and therefore all the elements were built up of hydrogen in some special way, he thought. As work progressed this simplicity was found to be superficial. Atomic weights were not whole numbers, and the more accurately many of them were determined, the more did the results deviate from the simple form to which the theorist (in an armchair, of course) attempted to make them conform. The elements appeared then to lack connection of any kind one with each other. Later, in the seventies the periodic system was put forward, a theory which indicated the essential simplicity of the chemical elements and their connection with each other, and which was sufficiently enterprising to allow the properties of undiscovered elements to be predicted. Yet subsequent research revealed horrid doubts. There were a few exceptional cases that could not be explained away by it. Was everything really so simple? When radio-activity was discovered matters became worse, for the new elements revealed by it seemed to give the periodic system its quietus. But no. Moseley's discovery of atomic number, and the discovery of isotopes reinstated the periodic system, explained the exceptional cases easily, and revealed indeed that it was much more fundamental in its truth than even its most ardent exponent had imagined. It simplified everything, provided we think of it in terms of atomic number and not, as the discoverers of it did, in terms of atomic weight. Lastly, Aston's work on isotopes in revealing the complexity of the simple thing we imagined an element to be has really made for simplicity, for, as I have stated above, he has shown that the isotopes have simple numbers as their atomic weights, suggesting that they are in all probability compounded in a very special way from the very simplest elements hydrogen and helium. This, indeed, is very like Prout's hypothesis, only Prout was in the dark; we, on the other hand, with a hundred years of research to help us, are beginning to see.

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[1] The chief workers in this field have been Professor Richards of Harvard and Dr. Hönigschmid of Vienna

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C. G. Darwin, Discovery, vol. i, p. 41.
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Tanning Materials. With Notes on Tanning Extract Manufacture. By Arthur Harvey. (Crosby Lockwood & Son, 15s.)

A technical work which should be useful as a reference work to tanners, students of the leather trade, and manufacturers interested.

Hector *v.* Ajax: A Mycenæan Duel

By W. R. Halliday, B.A., B.Litt.

Professor of Ancient History in the University of Liverpool

The discoveries of our early years have a long life. Two lucky "finds" in imaginative literature are vivid memories of my own childhood, which was endowed with that best of educations, the free run of a library. There I stumbled first on D'Artagnan's journey to Paris, which led to other breathless and inexhaustible delights of Dumas; and later upon a book, covered in blue cloth, inscribed with the then unknown names of Lang, Leaf, and Myers. The first introduction, which Fortune thus arranged, to what I found to be the best of story-books, was the combat of Hector and Ajax in the seventh Book of the *Iliad*: and this recollection has made it for me always a peculiarly favourite passage. The episode is also of considerable historical and archæological interest, for it describes a duel between warriors armed with the weapons of the Mycenæan period.

The Book opens after Hector, the Trojan hero, has taken leave of his wife Andromache and has shamed some manhood into the trifler Paris; sallying together from the Scæan Gate of Troy, the two brothers are making havoc in the Achæan ranks. Athene descends from heaven to the rescue of her Greeks, and Apollo follows to prevent her from unfairly turning the scale of battle against the Trojans. God and goddess meet at the great oak tree and agree to stay the conflict. Thereupon the wise seer Helenus prompts Hector to check the Trojan charge and to challenge the Achæans to send a champion to meet him in single combat. "It is not yet thy destiny to die and to meet thy doom; for thus I heard the voice of the gods that are everlasting." Characteristic this, perhaps, of romantic epic, but to our minds a little unsportsmanlike. Hector should not have known that he was safe in throwing down the challenge. But if we can forget it—and Hector may have been not so sure, for seers have ere now made mistakes—the rest is on a high note of chivalry. The battle is stayed and the stage for the single combat is set. "And Athene and Apollo of the silver bow in the likeness of vulture birds sat them upon a tall oak, holy to ægis-bearing Father Zeus, rejoicing in their warriors; and the ranks of all of them sate close together, bristling with shields and plumes and spears. Even as there spreadeth across the main the ripple of the west wind newly risen and the sea grows black beneath it, so sate the ranks of Achæans and Trojans upon the plain."

Between the hosts Hector advances and issues his knightly challenge upon the condition that the arms of the vanquished shall be the spoil of the victor, but the body is to be surrendered to his friends for honourable burial.

Awe strikes the Achæan leaders at his words until the spell is broken by the impetuous petulance of Menelaus, who is with difficulty restrained by his friends from hazarding an unequal contest. Old Nestor then querulously upbraids the younger generation with a tale of how he slew a giant when he was a younger man. "If I were not over age Hector should not lack an opponent." Human nature has not so very much altered between the Trojan and the European wars.

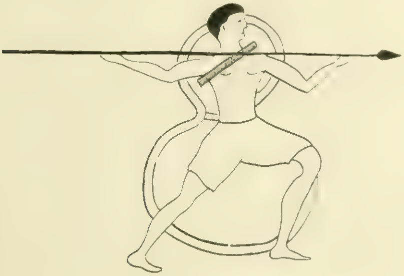

FIG. A.

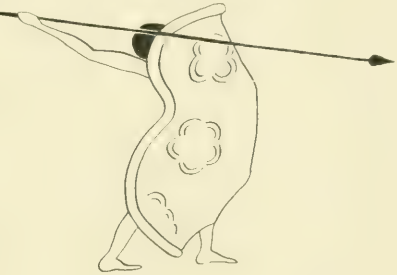

FIG. B.

Eventually nine volunteers mark each his token and place it in Nestor's helmet. "And knightly Nestor of Gerenia shook the helmet and there leapt forth the lot that they themselves desired, even the lot of Ajax. The herald bare it everywhither through the throng, shewing it from right to left to all the princes of the Achæans, but they knew it not and every man denied it. But when he came, bearing it everywhither through the throng, to him that had marked it and cast it in the helm, even to glorious Ajax, then he held forth his hand and the herald stood by him and put it therein. And Ajax saw and knew the token upon the lot and rejoiced at heart."

He dons his armour and strides into the field "with a smile on his grim face," huge and terrible, so that even Hector feels a sinking of the heart, though it is now too late to draw back.

Each champion in turn then vaunts his prowess at the expense of the other. The psychology of this is readily intelligible, and there is no need to turn to anthropology for parallels, though it would not be difficult to quote examples of savage braves working up their courage by similar means. Indeed, a street-corner brawl would probably provide an analogy. But there is a phrase of Hector's that challenges attention. "Ajax of the seed of Zeus, son of Telamon, chieftain of the host, tempt not thou me like some puny boy or woman that knoweth not deeds of battle. But well I know wars and slaughterings. To right I know, to the left I know to steer my tough oxhide; therein I deem is stalwart soldiering."

Hector, in fact, defines the art of fighting on foot in terms of manipulation of the shield.

The explanation of this curious detail can now be supplied by archæology. The Homeric poems depict a society in an age of transition; side by side with the Achæan invaders from the north, who are clad in metal body-armour and carry a round parry-shield ornamented with concentric circles and a central boss, there are fighting champions whose equipment is that of the Mediterranean Bronze Age which reaches down, roughly speaking, to the twelfth century B.C. Perhaps on account of climatic reasons the use of body-armour was not native to the southern Mediterranean; its absence was compensated by a large shield which covered the whole body (Fig. B). The most ancient type of shield in Italy, the form of which was preserved in the sacred shield of Mars, was Mycenæan in shape; and both Egyptians and Persians wore at most quilted body-armour, and depended for protection upon a large oblong shield. Cretan and Mycenæan art shows us a large shield of hide bound with a metal rim and ornamented with a blazon; it covers its wearer from chin to instep. Though its shape is sometimes oblong, its most characteristic form is a figure of eight. No doubt the cutting out of the two sides a little diminished the weight and also provided for some play of the arms. This "tower" shield, as Homer calls it, was attached round the neck by a strap and "steered" to right and left by a handle of wood which joined the two sides at [illegible] In the [illegible] piece was [illegible]

This weapon had some advantages. In action a man crouching behind it was completely screened. In retreat it could be slung upon the back as a protection against missiles,[2] and it was thus carried when not in use. "The black hide beat on either side against his ankles and his neck, even the rim that ran uttermost about his shield." To prevent the rim bruising the legs a kind of shin-pad fastened with a metal garter seems to have been worn. The big shield had also its uses when camping out. Odysseus describes how on a cold night outside Troy they lay in the brushwood under the covering of the large shields buckled round their necks.[3]

The disadvantages, however, of the big shield were great. Its weight was enormous, and Ajax must have needed all his giant strength to wield seven thicknesses of hide stretched upon a frame almost as tall as himself. In battle the weight hung upon the left shoulder, and there are constant references in Homer to the grave discomfort caused by the chafing of the strap. When Ajax was holding off the Trojans from the ships, "his left shoulder was wearied as steadfastly he held up his glittering shield."[4]

"On each man's breast," says Agamemnon, "shall the strap of his covering shield be wet with sweat and his hand grow faint about the spear."[5] When there is a lull in the fighting heroes hasten to relieve themselves of this cumbrous weapon. "Now verily did many and noble hosts of his comrades follow with the son of Telamon and bore his shield, when labour and sweat came upon his limbs."[6]

In action it was easy, as a warrior called Periphetes did, to trip upon the rim with fatal results. "For as he turned back he tripped against the rim of his shield which he was wont to bear, a shield that reached to the feet, a fence against javelins. . . . And Hector spied it and ran up swiftly and stood near him and fixed a spear in his breast."[7] There was then some reason for Hector's implication that the management of his shield was the test of a soldier's skill.

The two champions are opposite each other. At once the disadvantages of the "tower" shield are apparent. Both men crouching behind are completely covered, but both are hampered for offensive action by their protection, for they can only see if they raise their head; and they can use their arms with difficulty except at the price of exposure. "Howbeit," says Hector, "I have no mind to smite thee being such an one as thou art by spying thee unawares; but rather openly if perchance I may hit thee." A magnificent gesture, but in fact there was little use in manœuvring for an opening against a warrior of the experience of Ajax! As a rule the feinting for an opening is a feature of such combats. Either party edged himself forward on tip-toe ready to take advantage of any incautious exposure of his opponent or to dodge his blow. Quick footwork was essential. This is probably the explanation of the recurring Homeric phrase which is usually translated: "Lightly stepped he with his feet, advancing beneath the cover of his shield."

Reduced to direct attack, Hector attempts to drive his spear through his opponent's defence. Six folds of hide it pierced, but failed to penetrate the seventh; Ajax in his turn hurled his far-shadowing spear. "Through the bright shield passed the violent spear, and through the curiously wrought corslet passed it on and straight forth beside the flank the spear rent his doublet: but he swerved aside and escaped black death."[8] Nimble footwork enables Hector to dodge the spear-point as it penetrates the shield.

In the second round Hector again fails to pierce his adversary's defence, and this time Ajax wounds him lightly in the neck. Hector replies, no doubt taking advantage of the opportunity while the spear of Ajax is stuck fast in his (Hector's) shield, by picking up a stone and hurling it at his enemy's shield. He fails to upset him, but Ajax with a yet larger boulder is more successful. "So smote he the buckler and burst it inwards with the rock like unto a millstone and beat down his knees and he was stretched upon his back pressed into his shield; but Apollo straightway raised him up." He had need of divine intervention, for without it he was helpless at his opponent's mercy; the big stone knocked him over with the shield on top of him like a candle-extinguisher.

Abandoning shields the two heroes then fell to with swords, when heralds from either side intervene to prevent the fight being continued *à outrance*. Ajax

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[1] E.g. *Iliad*, xiii. 611. Peisandros having broken his spear "clutched his goodly axe of bronze under his shield."

[2] [illegible] xi. 545. Ajax "cast behind him his sevenfold shield of bulls hide and gazed in fear upon the throng, like a wild beast, turning this way and that and slowly retreating [illegible]

[3] *Odyssey*, xiv. 472. Contrast the use of the parry-shield as [illegible]

[4] *Iliad*, xvi. 106.

Ibid., ii. 388.

[6] Ibid., xiii. 709.

[7] Ibid., xv. 645. Similar scenes are sometimes depicted upon Mycenæan gems. For an accident with the big shield off the field of battle, see *Iliad*, xxi. 240, the quarrel of Achilles with the river-god Achelous. The water filled the hollow of Achilles' great shield, and, as it was attached round his neck, he was naturally dragged under and would have drowned but for the elm-tree.

[8] Homer has probably made a mistake in giving Hector a corslet. The weight of both armour and the big shield would have been insupportable. It is intelligible, too, that a man should dodge the spear-thrust as it penetrates his shield in front of him, but not the most agile could dodge a thrust through his breastplate

agrees to a truce if the challenger will first withdraw, and the combat ends with an exchange of gifts between the heroes and, upon Hector's side, a chivalrous expression of respect. " Ajax, seeing God gave thee stature and might and wisdom, and with the spear thou art excellent above all the Achæans, let us now cease from combat and battle for the day; but hereafter will we fight until God judge between us, giving to one of us the victory."

It is not difficult to understand, in the light of this encounter, why it was that, once body-armour was introduced, the Mycenæan way of fighting was doomed. Heavy and hot though it might be—and early Greek armour was both ill-fitting and heavy—the combination of armour and parry-shield worn on the left arm provided as effective protection as the "tower" shield: it was less difficult to manage, and it did not immobilise the fighter. Above all, it did not in the same way hamper offensive tactics. A duel between two warriors of the old school was inevitably something of a stalemate. It was difficult effectively to attack your adversary except by risking the abandonment of your own defence. Either you had to knock him over under his shield with a boulder, or, as may be seen in the fighting scenes engraved upon Mycenæan gems, you had to risk exposure, sling your shield round on your back, and spring at him, stabbing down with the short dagger of the Bronze Age over his shield, or catch hold of the top of it and use it as a lever on its strap which formed a noose about his neck.

In conclusion, some accidents of the further history of the shield may be noticed. We have noticed two main types of pre-historic shield—the Northern type, a round shield with a boss, the Mediterranean, an oblong or figure of eight as tall as a man and decorated with a blazon. The classical Greek shield was uniformly a parry-shield and usually round, though the Mycenæan shape survived in Bœotia and Arcadia. Blazons appear upon Mycenæan shields; the Homeric parry-shield has a boss, but no blazon; the classical shield has no boss, but is ornamented with a blazon. If we may trust the vase painters and the poets, a personal device was worn on the shield by leaders of the heroic age; in historical times the citizen soldiers carried the symbol or initial letter of the state to which they belonged, upon their shields. The blazon, indeed, made recognition possible, which must otherwise have been peculiarly difficult in the days before the vizor was invented and the " Corinthian " helmet, made in one piece, covered the whole face except the eyes and mouth. It was, of course, a similar necessity which led to the use of the blazon by the mediæval knight.

The Romans, unlike the Greeks, retained the Northern boss throughout their history. The earlier Roman army was armed with a round shield, but eventually the Samnite shield was adopted. This was the familiar oblong parry-shield of the legionary, which in shape, though not in size, conformed to a Mediterranean type.[1]

Some Modern Egyptian Graveside Ceremonies

By Winifred S. Blackman

Oxford Research Student in Anthropology.

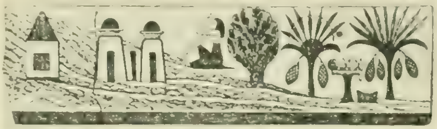

FIG. 4. ANCIENT EGYPTIAN WOMAN WAILING BY THE TOMB OF A DEAD RELATIVE.

DURING last winter, from January to the middle of April, I was engaged in studying the beliefs, customs, arts and crafts of the modern inhabitants of the Nile Valley, the chief part of my work being carried out in the province of Asyūṭ. I had been sent out as Research Student in Anthropology, under the auspices of the Committee for Anthropology in the University of Oxford.

The greater part of what follows has, so far as I am aware, not been published hitherto. Even Lane, in his classical work on the Modern Egyptians, gives no account of the *weekly* ceremonies described in this paper.

I lived, in company with my brother, in some of the rock-cut tomb-chapels in the limestone cliffs above Mīr. Our camp, situated half-way up the higher desert slope, overlooked the lower desert, beyond which lay the cultivation, dotted about with picturesque mud-built villages nestling among their palm-trees. Further in the distance rose the cliffs forming the edge of the eastern desert on the other side of the Nile. The scene was beautiful beyond description, and the glories of the Egyptian sunrises and the after-glow of the sunsets could be seen to advantage from this elevation.

Just below us were the graves of the humbler folk of ancient Egypt, those who could not afford the luxury of rock-cut tombs. Beyond them, nearer to the cultivation and almost in a line with our camp, lies a modern Muslim cemetery. The graves are mostly conical mounds of sand, surmounted by a palm branch or branches, stuck upright into the ground. In nearly all cases in this particular cemetery such an erection forms the only monument to the dead, the only indication of their last resting-place. A few more graves show a more elaborate covering, made of mud, and slightly resembling in form some of the houses of the living. Usually an earthen pot containing a plant of *ṣabar* (aloes) is placed on the side of or at the base of the mound. These plants are looked after with the greatest care, as both they and the palm branches stuck into the graves are believed to bestow blessings on the dead.

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[1] Upon Homeric armour, Ridgeway, *The Early Age of Greece*, and Reichel, *Über Homerische Waffen*, may be consulted. Ridgeway perhaps exaggerates the prevalence of the Northern type of weapon, Reichel that of the Mycenæan; and the truth lies probably between the two. As indeed might be expected in a period of transition between two civilisations, both types of armour were simultaneously in use.

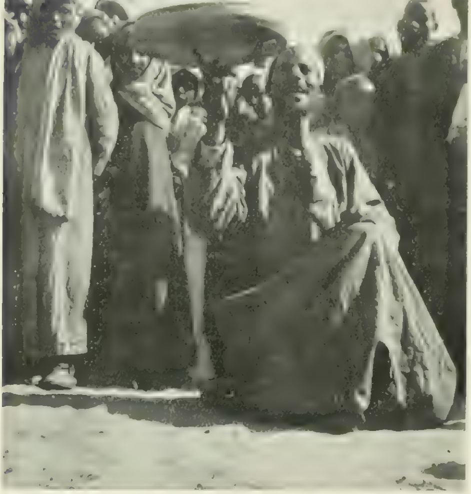

FIG. 1. POET RECITING AND TWIRLING DRUM IN A MODERN EGYPTIAN CEMETERY.

This cemetery is a wind- and sand-swept place. The palm branches quickly wither and assume the same colour as the surrounding desert. Seen from our camp, the shadows which they cast on the mounds are so dark that they give the impression of black-clad figures kneeling in perpetual grief, keeping watch by each grave. Similar cemeteries are to be found at intervals all along the lower desert.

Adjacent to the cemetery on its western side is the white-domed tomb of Hasan 'Ali. It stands surrounded by low walls of mud, within which enclosure are a well and several graves; trees and flowers are also planted here and are carefully tended.

. . . . .

Many a time I witnessed and, indeed, took part in the ceremony, which is described below, in this cemetery.

Eṭ-Ṭala', "the coming forth" or "the going up," is the name given to the periodical visits paid to the cemeteries by the relations and friends of the dead, the women expressing their grief by loud wailings. The name *eṭ-Ṭala'* is probably due to the fact that the people always speak of "going up" to, and "descending" from, the desert.

The weekly *Ṭala'* takes place either on Thursdays or Fridays. On one or other of these days the souls of the dead are believed to return to their graves, when they expect their relatives to meet them there. In the Fayūm and some other parts of Egypt, this visitation is believed to occur on Thursdays; in other parts, including Asyūṭ Province, Friday is the chosen day.

Early every Friday morning processions of women, often accompanied by their male relations, could be seen wending their way from Mīr and the neighbouring villages towards this desert graveyard. Some would be walking, some, especially the men, riding on donkeys. Before 7 o'clock the wailing could be heard plainly in our camp. It had a pathetic and not unmusical sound. A number of fiḳīhs generally joined in the processions, or were to be found waiting in the cemetery. Their business is to recite various passages from the Ḳoran by the gravesides, being hired by the mourners for this purpose. Some of the women would bring with them large baskets full of bread-rings, with which they rewarded the fiḳīhs for their services. The bread used for this purpose is nearly always made in this shape, though sweets of all kinds, cakes, etc., are also brought for distribution, especially by the richer people. The fiḳīhs' recitations are believed to be of great benefit to the dead. There were usually a certain number of the very poorest people present, as well as children, who had come in the hope of receiving a share of the gifts. One of these suppliants might say: "*Iddini ya sitt ḥaseneh*" ("Give me, oh lady, *ḥaseneh*"). The word *ḥaseneh* means "charity," and is a general term for the bread, etc., given away on these occasions, the special name for the bread-rings being *kaḥk*.

On presenting bread to the fiḳīhs or to the poor, the giver will say: "*Khud kaḥk 'ala ruḥ el-fullān*" ("Take a cake on behalf of the soul of so-and-so"), mentioning the name of the dead relation (Fig. 3). It is a moving sight to see the faces of the women contorted with grief, the tears streaming down their cheeks, as they crouch over the graves, swaying backwards and forwards. They hold in their hands coloured handkerchiefs, generally of silk, used only on these occasions or at a funeral. Sometimes a large one, often black with a coloured border, is doubled cornerways and placed round the neck of the mourner. With this she can vary her movements, taking hold of the handkerchief at each corner and drawing it backwards and forwards, like a saw, while she sways rhythmically from side to side. It should be mentioned here that all these movements, even those of the fiḳīhs when reciting, are strictly rhythmical.

With the smaller handkerchiefs with which the women wipe the tears from their cheeks, they also stroke and pat the grave. On one occasion I saw a young woman acting in this manner, just as if she were affectionately stroking a living person. She then knocked on the grave, calling, "*Ya abūya, Ya abūya*" ("My father, my father"). Some of these apparently grief-stricken mourners are merely professional wailing women paid for their services. Often, as I passed them, in the midst of what sounded like the most heart-broken sobs, they would look up at me, smiling in a friendly way, only to resume their sorrowful attitude the moment I left them.

Those who can afford it will often bring several large baskets of bread for distribution. I have seen six or seven such baskets piled up on a single grave, where a large party was assembled, a number of wailing women being seated at one end, whilst at the other was a large group of men and boys. The men were fiḳīhs who, swaying from side to side, were reciting passages from the Ḳoran, accompanied, as is very often the case, by the boys. When one set of repetitions came to an end, each performer had two or three bread-rings doled out to him by a man and one or two women, who appeared to be the chief mourners. Then the recitations began again, ending with a similar reward. All this time the women at the other end of the grave kept up their piteous cries, receiving in return exactly the same compensation as the fiḳīhs.

Presently one of the women, who had been assisting in the distribution of the bread-rings, took up a basketful, and, placing it on her head, started off, accompanied by another woman, to present the contents to mourners at other graves. They perambulated most of the cemetery, giving bread-rings to women who had none. The acceptance of such a gift implies that the receiver is willing to be on friendly terms with the giver. Sometimes the donor meets with an angry refusal from the woman to whom she presents bread. This implies that there have been quarrels between them. In such cases bystanders will intervene, urging the acceptance of the gift, and the duty of living at peace with each other and making up the quarrel. These peace-makers are usually successful, and the gifts are finally accepted, though sometimes it requires considerable persuasion before a reconciliation is effected.

This weekly ceremony usually lasts from two to three hours, after which time the women take up their now empty baskets, the men who have donkeys mount them, and the whole procession returns to the villages, the women wailing as they go.

Very similar ceremonies take place on the fifteenth and fortieth days after a death. The mourners, accompanied by their relatives and friends, repair to the cemetery, carrying with them baskets full of bread-rings, cakes, sweetmeats, etc., for distribution, and branches of palm leaves to place on the grave. On these occasions, not only a large number of poor people, but also numbers of fiḳīhs, who know that their services will be required, crowd to the cemeteries, in the hope of receiving some of the food given away in the name of the dead person.

Again on *el-'Id es-Sugheiyir*, the Little Festival, which takes place at the expiration of the fast of Ramadan, most families, but chiefly the women members, repair in like manner to the cemeteries, carrying with them gifts similar to those mentioned above, together with a number of palm branches.

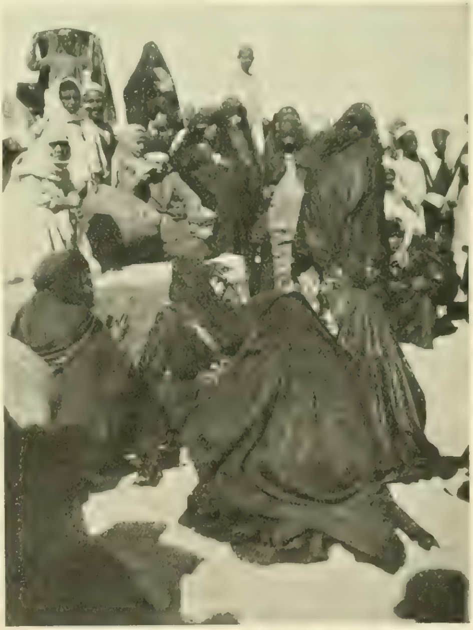

FIG. 2. WAILING WOMEN BEATING THEIR HANDS TOGETHER NEAR A GRAVE.

The [illegible] are sometimes broken up first and then placed on the graves.[1]

This rite is repeated on *el-'Îd el-Kibīr*, the Great Festival, which takes place in commemoration of the sacrifice of Isaac.[2]

. . . .

The Copts have three very similar annual ceremonies. One on either January 18 or 19, called *Yōm el-Ghiṭās*, the Festival of the Epiphany, another on Good Friday, and a third in the middle of June, on the occasion of a festival in memory of St. Mary. The name *Ṭala'* is also bestowed on each of these religious rites.

I had the good fortune to be present at the *Ṭala'* on *Yōm el-Ghiṭās*, and witnessed the whole performance.

Lane, in his book on the Modern Egyptians, gives a short account on page 545 of what follows this festival, but gives no details of the ceremonies on the day of the *Ṭala'*. On page 552 he alludes to the fact that it is a custom of the relatives of the dead to visit the graves on that day, and mentions that animals are sometimes sacrificed on these occasions, their flesh being distributed among the poor. No such sacrifice took place at the cemetery which I visited this year, so far as I am aware.

Very early in the morning a continuous wailing sound penetrated as far as our camp. The cemetery in question was about six miles off, adjacent to the monastery of Dēr el-Maḥarraḳ. Curiously enough, the Muslim cemeteries were also filled with women wailing at the graves—in sympathy with the Copts, according to one of my informants. The first thing to catch the eye on arriving at the Coptic cemetery was a large group of women indulging in a curious dance close to some of the graves. It consisted in a stamping, circular movement, the women being closely packed together the whole time.

The cemetery was very crowded, and visitors on camels, horses, donkeys, or on foot, were constantly arriving. Others, having paid their tribute to the dead, were departing, wending their way to the various villages in the cultivated area. All this time the wailing never ceased. It was, to my mind, the most pathetic sound I had ever heard. The monastery made a picturesque background for the whole scene; moreover, its walls afforded a welcome shelter from the sun for horses, donkeys, and camels that were tethered beneath them.

The groups of mourners varied in size, some being quite large and consisting of about twenty people, or possibly more. Sometimes a woman could be seen wailing in solitary grief. I noticed one such woman talking to her dead husband through a small hole pierced at one end of the tomb. Coloured silk handkerchiefs, similar to those used at the weekly *Ṭala'* of the Muslims, were in evidence at this ceremony. The graves, especially those with no superstructure, were covered for the occasion with a rug, called *kisweh*, generally of a striped woven material such as is often placed on the floor or on a *masṭabeh* for a guest to sit on. The women appeared to have made no change in their dress for this occasion, but in most cases their hands, arms, and faces were dyed blue as a sign of mourning, a custom which possibly dates back to very early times, for the ancient Egyptian women seem to have worn blue clothes at funerals as a mark of grief.[3]

The superstructures over the graves show very little variation in form in this cemetery. They are rectangular structures with barrel-vaulted roofs. Similar superstructures were erected above graves in ancient times.[4] Many of them were covered with white paint, with simple designs in blue or red; in some cases, both colours were used for decoration on a single tomb. Sometimes a text from the Bible was inscribed in Arabic, in red or blue paint, along one side of the monument, a cross being frequently either painted or incised at one end.

At one grave there were a number of women, their faces and hands streaked with blue dye, each one holding a silk handkerchief, either mauve or green in colour, with which they gently stroked and patted the grave as they wailed in piteous tones, "Still young, oh my brother," evidently addressing the dead. By another grave there was a large concourse of people, some seated higher up on an adjacent tomb (Fig. 2). Here a widow was bewailing her dead husband in the following words: "Come and get up! See the weariness (or sorrow) of me and of my children. See how your eldest son has wearied me, and how your brother has oppressed me. You have left me alone with young children. Who will feed them, and who will clothe them?" etc. After this harangue, the wailers took up their part, smiting their hands together and striking their cheeks to the rhythmic beats of a shallow, single-membrane drum, called *nadam*. When the wailers ceased, the widow again started her lament, other women sometimes joining in, as a sort of chorus. Passing friends stopped and endeavoured to console her; and one of her young children, who was seated near her, embraced her from time to time. The grave was covered with a *kisweh*, and the *nadam* was bedaubed with blue dye. The widow held two handkerchiefs knotted together, one in each hand, and with these she alternately wiped the tears from her cheeks and patted the grave.

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[1] E. W. Lane, *The Manners and Customs of the Modern Egyptians*, London, 1895, pp. 485–87.

[2] Ibid. pp. 493–94.

[3] A. H. Gardiner, *Zeitschrift für ägyptishe Sprache*, vol. xlvii, 1910, pp. 162 f.

[4] See e.g. D. Randall MacIver and C. L. Woolley, *Buhen*, pls. 81 and 82. Petrie, *Tarkhan*, ii. pls. xx f.

Meanwhile, in another part of the cemetery, a Coptic priest was going from grave to grave, censing both the mourners and the tombs, in return for which service he was sometimes presented with additional incense or with a certain amount of grain. Grain thus collected is generally distributed afterwards to the poor. Water-carriers were busy plying their trade, or occasionally offering a free drink in the name of a dead relation. A sweet-seller was also advertising her wares by means of a tin rattle, similar to those bought as children's toys, fixed on to the top of a long stick round which was twisted a thick sugary substance. Close to the cemetery a market was in full swing, where, besides various foods set out for sale, rattles and other toys as well as small tin cups could be bought for the children. The cups were hung round with small heart-shaped pieces of tin, which jingled against the sides. Such cups are bought and presented to the children by their parents in memory of this day's ceremony. On another part of the ground a professional poet was entertaining a large crowd. On seeing me, and on my presenting him with a small sum of money, he started reciting a poem in my honour, of which the only words to be distinguished were those with which he wound up the oration—" God will that you return safely." He very cleverly twirled on one of his fingers a drum, resembling in shape the *nadam* used by the wailing women, and in it he collected money from the bystanders (Fig. on cover). His attendant was provided with a similar instrument on which he beat an accompaniment to the poet's recitations.

Gifts of bread, sometimes in the form of flat loaves, sometimes in rings, as well as dates, sweets, etc., are often given to the poor at this festival in the name of a dead relation.

The cemetery at Dēr el-Maḥarraḳ abutted on to the desert which stretched away into the distance, where rise the limestone cliffs, forming the barrier between the lower and upper deserts.

The festival lasts till sunset, when all who have remained in the cemetery up to this time return homewards, wailing as they go. Often, even after they have reached their homes, they continue their demonstrations of grief, striking their faces and beating their hands together, as they have done at the graveside. On such occasions their neighbours will come to condole with them. As night falls the wailing ceases, and the next day work goes on as usual.

. . . . .

A study of the religious ceremonies connected with mourning for the dead among the ancient Egyptians, reveals interesting and instructive parallels to the rites of both Copts and Muslims just described.

I am indebted to my brother, Dr. A. M. Blackman, for my information on these earlier customs. From the earliest times it was the custom to honour the memory of the dead at certain definite periods. The name given to this ancient rite was *Prt*, meaning " the coming forth," or " the going up." The word *Ṭala'*, as I have stated above, has an exactly similar meaning. From the same root is derived *ṭulu'*, used in the combination *ṭulu' esh-shems* (" sunrise "). *Prt* has also this meaning in Egyptian. Both the Egyptian *pry* and the Arabic *ṭala'* are the regular verbs used with the meaning " to rise " of the sun.

In ancient Egyptian *prt* (= Arabic *ṭala'*), in its technical sense of " ascent," " going up to " or " procession to " the necropolis, nearly always appears in the combination *prt-r-ḫrw*, meaning " a coming forth," or " a going up, at the voice " (i.e. with offerings to the cemetery), the " voice " being originally that of the living king (= Horus),[1] bidding the offerers draw nigh to the grave of his predecessor, the dead king (= Osiris). Later, of course, the " voice " was the voice of the mortuary priest who replaced the king, Horus, at the funerals of his subjects, or who acted as king's deputy at royal tombs.

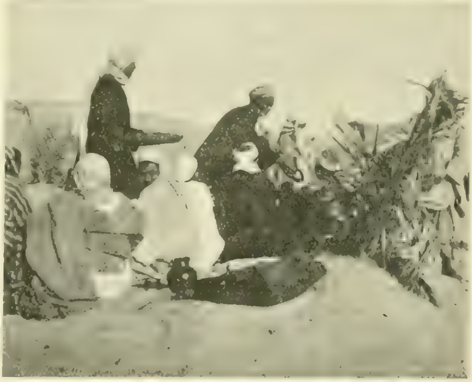

FIG. DISTRIBUTING BREAD RINGS TO FIḲIHS AT THE GRAVESIDE.

In the tomb-chapel of Methen, who lived at the end of the Third Dynasty, the following formula occurs: " Grace granted by Anubis who presides in the Necropolis, a ' coming forth unto the voice ' there by all his (i.e. the deceased Methen's) villages (that formed his mortuary endowment) on the *wāg* festival, . . . the first day of the month, the first day of the half-month, the first day of every week."[1] A similar text, probably of the Sixth Dynasty, runs as follows: "A 'coming forth unto the voice' for him in his tomb-chapel, at the monthly and half-monthly festival, on the firsts of the seasons, the firsts of the months and the firsts of the weeks."[2] In later times this weekly offering seems to have degenerated into a mere pouring out of water at the grave, to the recitation of formulæ, a custom that still survives in Lower Nubia and Upper Egypt.[3]

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[1] N. de G. Davies and A. H. Gardiner, *The Tomb of Amenemḥēt*, London, 1915, p. 85.

Prt occasionally occurs in its funerary significance without the following *r-ḫrw*, and it then seems always to be accompanied by the attribute *ʿȝt* ("great"), i.e. "the great going forth," or, to use the modern equivalent, "great *ṭalaʿ*." For example, a man prays that on the day in which he departs this life there may be "a great going forth of my fellow townsfolk." The same expression is found in the Canopus decree, where it is employed to denote the annual commemoration of the death of the deified Berenike.[4]

In the Greek version of this last-mentioned inscription, *prt ʿȝt* is rendered *μέγα πένθος*, "great lamentation," an indication that those taking part in this "coming forth" wailed at the graveside, and probably on their way there and back, as is indeed the custom in modern times.

In view of the evidence obtained from the meaning of the names given to both the ancient and modern rites, together with many similarities in the mortuary ritual of the ancient and modern Egyptians, as well as the interesting fact that "the going up" was in both instances to the same desert, we have some justification for supposing that the modern ceremonies are in origin pre-Islamic—indeed, pre-Christian—and are direct ritualistic survivals from the earliest period in the history of this remarkable and interesting country.

It may be of interest to readers of this article to compare the representation of an ancient Egyptian woman wailing at the tomb of a dead relation with the photographs which I took of modern Egyptian women similarly engaged (Fig. 4).

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[1] A. M. Blackman, *Journ. Egyptian Arch.*, vol. iii, 1916, p. 32.

[2] Ibid.

[3] Ibid., ff.

[4] H. Schäfer, *Die Mysterien des Osiris in Abydos*, p. 25.

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The Parentage of Invention

By Herbert W. Horwill, M.A.

THAT necessity is the mother of invention is one of the most commonly accepted of our ancient saws. But the inventors themselves do not all endorse it. "No such thing!" declared Mr. Louis Brennan, in an interview some years ago. "Accident is the mother of invention in ninety-nine cases out of a hundred."

The exact percentage would, perhaps, be difficult to reach with any scientific precision. There are many instances that might be quoted to challenge Mr. Brennan's dictum. Soviet Russia has been supplying some of them. Mr. Arthur Ransome has told us how the shortage of the usual material has led to the manufacture of matches with waste paper as a substitute for wood, and with the grease that is left after cleaning wool as a substitute for paraffin. The spur of necessity has similarly stimulated the invention by the brothers Chilikin, of the Centro-Textile factory, of three distinct processes for combining flax and cotton in such a way that the mixture can be worked in machines intended for cotton only. In a measure even Lord Kelvin's famous solutions of certain problems of navigation—his improved compass, his flying soundings, and his modification of coast lights—may be attributed to necessity, for they followed his purchase of a cruising yacht and his consequent realisation of the need for some better devices than those already in use.

Mr. Brennan's generalisation, no doubt, was largely inspired by his own experience in the matter of his torpedo. He did not start by saying: "Go to! Let us find out how to make a torpedo that will beat anything of the kind now on the market!" Through his observation, in an engineering workshop, of the behaviour of a frayed driving belt that was working a planing machine, he stumbled upon the mechanical paradox that it was possible to make a machine travel forward by pulling it backward. Having discovered the principle, he cast about for some object in connection with which it could be practically utilised, and it was not until he had thought of almost everything else that the idea of a torpedo entered his head. Once the idea did enter his head, the thing was as good as done.

The history of the Brennan torpedo might be paralleled in the career of numerous inventors. First there was the observation of something that was either unusual or commonly overlooked, and then the illuminating flash that revealed how it might be turned to practical account. Often the accident itself is in the nature of a blunder or a misfortune. Carelesss workmen in a paper-mill omit to add any size to the pulp, and the result is a parcel of paper that is thrown aside as waste. Someone, happening to use a scrap of this "waste" to write a note, discovers its absorbent character, and straightway blotting-paper is invented. The feeder of a lithographic machine fails to place a sheet of paper in position at the right moment, and consequently it does not pass through the machine. But the work on the printing surface leaves its full impression upon the covering of the printing cylinder, and when the next sheet passes through it receives the direct impression from the printing surface whilst an indirect or set-off print is made from the back upon the paper. Mr. Ira W. Rubel happens to be standing by, and the accident starts him on experiments which lead to the invention of the off-set method of printing.

The burning of a starch factory on the banks of the Liffey reveals the adhesive qualities of scorched starch mixed with water, and introduces to the world a new and cheap gum. A glass-cutter at Nuremberg accidentally lets some aquafortis drop on his spectacles, and etching on glass soon follows. While researches are being carried out in a German laboratory, a thermometer breaks, and the mercury runs out into a heated mixture of naphthalene. The oxidation completed by the catalytic action of the sulphate of mercury resulting, shows a method of overcoming the one hindrance in the way of making the manufacture of synthetic indigo a commercial success. A laboratory attendant supplies antifebrin in place of naphthalene, and his blunder leads to the discovery of the anti-pyretic properties of the former substance.

The history of photography is full of examples of the fruitfulness of chance oversights. Daguerre is careless enough to lay down a silver spoon upon a plate that he has treated with iodine. He notices that the image of the spoon is retained, and thus learns that a plate so treated is sensitive to light. Through putting aside one of his silver plates in a cupboard overnight, he discovers the effect of vapour of mercury on a sensitive plate. Mr. Fox Talbot accidentally lets one of his exposed papers come in contact with a solution of nutgalls, and thus ascertains the virtue of gallic acid. That uranium gives off invisible rays is discovered by Becquerel through putting some of it by in a drawer with a photographic plate, and finding an image formed upon the plate though it has not been exposed to sunlight.

This brief selection of items from the history of photography is a reminder that not all mentally stimulating accidents are associated with breakages or blunders. The part that accident plays in the process is the casual bringing together of circumstances in which the alert and observant mind discerns possibilities hitherto unrecognised. The point is that the opportunity of observation comes by accident and is not deliberately sought or arranged. It was not from any set purpose of forwarding his own scientific experiments that Montgolfier one day undertook the responsibility of airing his wife's gowns, when she was called to leave the house. He observed, while engaged on this task, that the gowns became inflated and tended to rise when filled with heated air; and Madame Montgolfier, on her return, found her husband sending up little paper balloons and thus originating the invention which made him famous.

In such instances the obvious essential, if there is to be any result of value, is that the observer shall have that capacity of detecting analogies which Professor Bain described as "the intellectual power of Similarity." He discerns the underlying identity of processes that, on the face of them, seem to have no connection whatever. Some years ago an Ohio business man had a shop in a good situation, and many customers, but somehow it was not profitable. There was evidently something lacking in his methods, and he worried so much on the subject that he found it desirable to take a holiday. While on his way to Europe he was standing one day in the ship's engine-room, when his attention was attracted by the automatic indicator of the propeller shaft's revolutions. The question suddenly occurred to him: "Why not devise a machine for recording sales in a shop?" Hence the invention of the cash register. At the hearing of a Dunlop appeal case in the House of Lords in December, 1920, it was mentioned that the idea of the pneumatic tyre was suggested by the tying of a piece of water-piping around the wheel of a wheelbarrow. The use of the stiff collar is due to the mental alertness of a blacksmith's wife in Troy, N.Y., who, somewhere about the year 1825, was washing her husband's shirts, which, according to the unvarying custom of those days, had the collars attached to them. It occurred to her that a shirt lasted clean longer than the collar. She started making collars separate from shirts and selling them to her neighbours. The idea caught on, and before 1840 several collar-making companies were doing a good business. When one is talking about collars one recalls another device which is due to the forethought of a British officer's wife for the safety of her husband. As Sir George Lusk was about to start on one of his Indian campaigns, Lady Lusk sewed some strips of chain under the cloth between the collar and the shoulder of his tunic as a protection against chance sabre cuts. This answered so well that chain shoulder straps were afterwards officially adopted for all ranks in the British Army. It was quite another type of accident that put George Westinghouse on the track of his chief invention. While on a railway journey in America he was aroused to compassion by the quiet persistence of a tired-looking young woman who was trying to sell magazines to the passengers. Out of sheer pity he bought one of her wares. His charity was amply rewarded. In the magazine he happened to buy was an article, describing a compressed-air borer in the Mont Cenis Tunnel, which gave him the clue for his pneumatic brake.

At least one valuable invention was the offspring of sheer laziness. In 1846 a railway pointsman, who had to attend to two station signals some distance apart, decided to save himself the trouble of walking to and fro between them by fastening the two levers together with a long piece of wire. A broken iron chair served as counterweight. The wire ran on into his hut, where he sat nightly by his fireside and worked the two signals without setting foot outside. Presently the railway authorities found it out, reprimanded the lazy pointsman for his indolence, promoted and rewarded him for his ingenuity, and adopted his invention.

Revolutionary Movements in Modern Painting

By Edward Liveing, B.A.

EVERY great era of art and literature has been preceded by a period of crude and restless experimentation. It is in such a period, so far as one can judge, that we are living at present. In music our ears are being accustomed to those strange, weird discords that are floating to us from Prague, Buda-Pest, and Vienna. In literature we have been both blessed and plagued by the rapid rise, especially since the war, of the *psychological* novel, whose origin does not lie, as so many critics have pointed out, merely in the development of psycho-analysis, but goes as far back for its origins as the great Russian novelists of the nineteenth century, Dostoievsky and Turgeniev, and, somewhat later, the delicately introspective studies of Tchehov and, in France, the bitingly introspective tales of Guy de Maupassant. The *psychological* novel is only part of a general tendency in modern fiction to represent life more truly and accurately in every detail. In poetry we have had for more than a decade our exponents of a similar realistic method, which found its opportunity in the war and gave us the harshly powerful poems of Siegfried Sassoon and the impressionistic verses of the *Imagistes*.

It is in the art of painting, however, that the greatest revolutions have taken place. Some of their creations have lately penetrated the portals of the Royal Academy, and have also appeared side by side with those of the "Academics" in that interesting *Nameless Exhibition* held during May and June at the Grosvenor Galleries.

Too much praise and too much censure have been showered on these new movements. Before pronouncing judgment upon them, we need to discriminate very carefully between their various branches and tendencies. Nothing better has been done in this direction than by Mr. Frank Rutter in *The Edinburgh Review*[1] of last April. To his enlightening article I am largely indebted for the following remarks, and I heartily recommend it to those who desire further knowledge about these new schools.

It is an interesting fact that science has been the most important factor in their origin. Science gave us photography; it also taught us that the colour of light is not just yellow or white, and that the colour of darkness is not merely black. Photography destroyed the idea so long entertained by artists and expressed by Sir Joshua Reynolds that painting was the accurate presentation of "the forms which Nature produces." Painters had to seek a new excuse for the existence of their art, and it was this urgency that evolved the school of *Impressionism*.

Impressionism started in Paris soon after the Franco-Prussian War. Its main ideas were to portray our first, sudden impressions of scenes and objects, accentuating the lines and features that we notice immediately, and omitting details not assimilated by our minds till later; and, in the place of the former *whites* and *blacks* for light and darkness, to substitute their true colours discovered by the study of optics. This is the reason why light is so often painted by the *Impressionists* with *blues* and *yellows*, and darkness with *blues*, *greens*, and *purples*. The two chief exponents of *Impressionism* are Monet and Pissarro. The latter's pictures have been largely exhibited in England.

Neo-Impressionism and *Divisionism* constitute a more scientific development of *Impressionism*. They were brought about by Seurat and Signan in the nineties and aimed at a more scientific contrast of colours. For instance, in order to obtain the colour grey, the artists of these schools would place green and violet side by side with each other, the colours blending at a distance into the single required colour.

Post-Impressionism was, peculiarly enough, started by an Impressionist,[2] Paul Cézanne (1839–1906.) His desire was "to make of *Impressionism* something solid and durable like the art of the old masters," and he used its colour methods chiefly for the purpose of imparting an appearance of solidity to still life. His follower, Van Gogh (1853–1890), a Dutchman, devoted himself more to human studies, gaining his colour effects by the blending of lines of colour. Paul Gauguin (1848–1903) supplies the romantic element in the movement, and, indeed, though not a great artist, it was he who inspired the reaction against the *realism* of the *Impressionists*. He went to live in Tahiti, where he led, or believed he led, such a pleasantly barbarous life that he became obsessed with the idea that civilisation was a disease. It was more through his letters than through his paintings that he advocated those theories which gave rise to the school of *Fauvistes*.

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[1] The article referred to is "Extremes of Modern Painting, 1870–1920."

[2] For a study of the work of this great artist see articles by M. Maurice Denis in *The Burlington Magazine*, Nos. 82 and 83 (2/6 per number).

The *Fauviste* movement was originally a Paris movement. The *Fauvistes*, tired of the scientific methods of the *Impressionists*, said in so many words, "Art is getting jaded by civilisation. The only way to restore it is to start all over afresh." So they threw away all traditions and started to paint as they considered savages or children would paint. Their creations have outdone Margaritone and Cimabue, the early Italian painters, for simplicity and angularity. The chief exponent of this school is M. Henri Matisse, and its followers in England, Mr. J. D. Fergusson and Miss Anne Estelle Rice.

Cubism sprang out of the attempts by the *Fauvistes* to exaggerate the angularities and cubic forms used by Cézanne to give objects the appearance of solidity. Its methods are based on the obviously fallacious argument that a "painting entirely composed of straight lines is stronger and, therefore, more beautiful than a painting containing curved lines." Its early exponents cut up their objects for representation into geometrical forms. Its later followers, headed by M. Picasso, a Spaniard, have made it still more complicated by shuffling those forms. For instance, if they wish to represent a simple object like a vase, they show bits of its exterior and its interior, and chips of shade and light all mingled in an indiscriminate mass.

This sectional representation of objects has been developed by an Italian school, the *Futurists*. To my mind their work is based on a stronger creed than that of the *Cubists*, for they use their straight lines, their angularities and cubes to express movement and the sensation of movement. In a sense, therefore, their pictures attempt to express abstract ideas, as well as to represent objects. Wassily Kandinskay, a Russian, whose pictures have been largely exhibited at Munich, has gone further still, and has attempted to represent by lines and colours nothing but abstract ideas and emotions. His *Expressionism*, as he calls it, endeavours to do what music does—to give sensations and emotions without using material associations.

These movements had little following in England till after the *Impressionist* exhibition at the Grafton Galleries in 1910. Mr. Walter Sickert introduced the mosaic-like quality of the *Impressionists* into his work, but has generally confined himself to reproducing soft lights and shades. The reaction against *Impressionism* is represented in the works of Mr. Augustus John. He is what I should call an "atmospheric" painter. After looking at a picture such as *The Ballad Seller* shown at the *Nameless Exhibition*, the impression that one takes away from it is not so much one of an unkempt woman, with a sheaf of ballads in one hand, a baby on the other arm, and a dirty child at her side, as of a sensation of hopeless squalor. Again, after looking at his portraits, it is the character of the person portrayed rather than the outlines of his face that one takes away as a lasting impression.

A British product is *Vorticism*, though this is really a combination of *Cubism*, *Futurism*, and *Expressionism*. Some critics consider that Mr. Wyndham Lewis is its most capable exponent. He is perhaps its most typical exponent. To me his work is repellent, and I far prefer the productions of Mr. Nevinson. This great young artist has used the methods of the *Vorticists* moderately and with a definite effect. He had, of course, his opportunity in the war, the sensations and atmosphere of which his lines and angles and slight distensions of objects rendered with an uncanny power. No one, who has seen them, can forget the vividness and *shock* of his exploding shells or the life-likeness of his haggard soldiers in the trenches. As he gauged the destructive, machine-like atmosphere of modern war, so Mr. Edward Wadsworth, also using *Vorticist* methods, has since gauged the sordid, machine-like atmosphere of the Black Country.

One has to take most of these modern movements in painting "cum grano." Many of them by accentuating single ideas or methods are decadent. But it is a dangerous thing to laugh at them as mere "rubbish." They are experiments which may gradually consolidate themselves into something more permanent and valuable.

The idea of *Expressionism* is peculiarly interesting. How successful will ever be the method of conveying emotions and sensations by colours it is difficult to prophesy. That colours have soothing and diverting effects on individuals was shown to a certain extent by their application to cases of shell-shock during the war. Here, however, we enter into a land of conjecture. . . . The period, when painters, by means of arrangements of colours, will be able to play on our emotions as fully and deeply as musicians, is probably as far off as the period when scientists will keep us alive on gases instead of solid food.

Reviews of Books

Roman Essays and Interpretations. By W. Warde Fowler, M.A., Hon. LL.D., etc. (Oxford, at the Clarendon Press, 1920.)

The attitude of a people towards its ghosts is probably among the most typical of national characteristics. The gradual evolution from fear to veneration, from distrust to some kind of worship, leaves its mark in language and in custom. And however enlightened or even agnostic be the trend of a nation's thought, there always lingers the dim, half-conscious sense that somewhere there is a half-open door, behind which lurk beings untrammelled by the laws which hold good for waking hours and broad daylight.

The monumental work of Sir James Frazer, in *The Golden Bough*, besides being as entrancing a fairy-book as was ever penned, is a history of the ways of man's thought, and a history which is probably more accurate than the researches of psycho-analysis and the introspection of the modern psychological novelist. And in a collection of charming essays by Dr. Warde Fowler—whose recent death removes a unique figure from English literature and scholarship—there are some striking instances of a nation's progress in its attitude towards the "world of spooks."

Speech, said the cynic, was given us to disguise our thoughts. But to the philologist words are living memorials of thought. It is a ludicrous criticism of human procrastination that "bye and bye" once meant "immediately"! And in *Roman Essays and Interpretations*, Dr. Warde Fowler has traced the varied history of the Latin word *religio* in such a way that we can follow more than one change in the Roman attitude to the unknown.

Once on a time it just signified magic. The mole, says Pliny, is *religionis capax*, i.e. a creature of importance in "religion," because its heart and teeth are charms against disease! *Religio* was the feeling that inspired Kubla Khan's warning,

> "Close your eyes with holy dread,"

and "holy dread" is probably the best translation of its primitive meaning.

But, although the word always retained some of this spirit of the uncanny, the growing orderliness of Roman society gradually narrowed down its use. To Cicero—a man superficially agnostic and anti-religious, yet capable of sending a surreptitious note to his wife to bid her propitiate the gods—it signified the spirit that led to the cults by which malevolent beings were quieted. *Religio*, therefore, had come to have a more soothing meaning; the mind of the Roman citizen, intolerant of mystery, had tidied up its thoughts of ghosts or other unseen potencies, and found, as it thought, the way to deal with them.

And then, by a further transition, the word became coloured by the philosophies of Greece, and began to develop something of the higher meaning it has to-day. The ideas of good and evil, the altruistic spirit of ethical justice, of the subordination of the individual to the general welfare, gained a hold on man's feelings and crept into this word. And in the Christian era it came to be used to express the whole range of Christian doctrine and practice, though always carrying a certain stern or negative note not present in such words as "Faith" or even "Church."

So the word that once stood for fear finally came to imply deliverance from fear; and whereas it once served to designate the unknown, eventually it symbolised man's most intimate beliefs and confidences. And the monk of the Middle Ages was *religiosus*—dedicated to good works; although to Pliny the word could only have meant "possessed of wizard power."

If words can thus accurately record the history of a mental attitude, traditional customs can often throw a light on the side-lines that go to make nations' characteristics. For instance, in Ireland of to-day the fairy-world is something Puckish, mischievous and care-free, a little world on a different plane from the human, just slightly out of focus. The Leprechaun is a kindly sprite, all things considered—a being of airy lightsomeness, with whom one can live on very friendly terms. It may be unfair to contrast the material features of modern spiritualism—the unimaginative attitude which tolerates in its ghosts what seem rather meaningless habits of tambourine-jangling and unintelligible spirit-writing. However that may be, it seems that the Romans had a kindly attitude to their store of ghosts. In Rome there was an ancient underground granary, the kind of pit still common in Palestine of our day, and no doubt the kind into which Joseph was thrown in his. In them the seed-corn once used to be preserved after harvest. All over the world the seed-corn has at one time or other been reverenced, and the reverence still holds in many lands. There were many festivals in ancient Rome on which the harvest was celebrated with careful religious ritual, and in early Rome on three autumn days this seed-corn-pit was opened to receive its store, after the festivities of harvest.

Later, this practice of public storage ceased. But still the pit was duly opened on these dates. And then, folk said, the ghosts would wander around and seek old haunts. It was a kindly thought—and not perhaps a common one, or a common attitude to the poor things. It must have provided a spice of romance to many a Roman child. What would Charles Lamb have given, whose childhood revelled in witches and other night-fears, for days on which each corner might hide its spirit, on its yearly day out?

In Spain to-day, on All Souls' eve, the villagers repair to the churchyard, and there hold a feast to which the departed are invited. All Hallow's E'en, in this country, is still regarded as the night when spirits wander. But there was something delightfully practical in the Roman way of removing a cover and letting your ghosts out!

There are many other essays in this volume typical of the wide and most human interests of its author—illuminating analyses of lines from Vergil, and two striking biographies of Niebuhr and Mommsen, those Napoleonic names in the world of scholarship. But the general reader will perhaps most appreciate the spirit of genial sympathy which pervades it, and which brings the world of Rome, and the fears and hopes of a dead age, into close touch with all that we feel and know to-day.

R. J. V. PULVERTAFT.

When Buffalo Ran. By GEORGE BIRD GRINNELL. (Newhaven, Connecticut: Yale University Press; London: Oxford University Press, 10*s.* 6*d.*)

It is not often that a book like this one comes all the way across the sea and reaches me. If all the books of the Yale University Press are like this one, happy must be the readers of them. It is a delight to handle, to read, to behold.

The publishers describe this book as a true story of Red Indian life before it was influenced in any way by the white man. It is written from the recollections of an Indian who was a boy seventy years ago, and the experiences extend from the time of his youth until his marriage. It is a genuine piece of writing done in a light and easy style, not in the least sensational, but interesting and instructive in a quiet way. It is not a continuous piece of fiction, but a series of a dozen sketches covering the most vital interests of the Indian as reflected in his daily work. The titles of some of these sketches are: "The Attack on the Camp"; "The Way to Live"; "Lessons of the Prairie"; "A Sacrifice"; and "A Warrior Ready to Die." As an example of the simple but excellent style a portion of the chapter entitled "On a Buffalo Horse" may be quoted:

"It was not long after this that the buffalo were found, and when the tribe went out to make the surround, my uncle told me to ride one of his horses, and to keep close to him. As we were going toward the place where the surround was to be made, he said to me: 'Now, to-day we will try to catch calves, and you shall see whether you can kill one. You may remember this, that if you shoot an arrow into the calf, and blood begins to come from its mouth, it will soon die; you need not shoot at it again, but may go on to overtake another, and kill it. Then, perhaps, after a little while you can chase big buffalo. One thing you must remember. If you are running buffalo, do not be afraid of them. Ride your horse close up to the buffalo, as close as you can, and then let fly the arrow with all your force. If the buffalo turns to fight, your horse will take you away from it; but, above all things, do not be afraid; you will not kill buffalo if you are afraid to get close to them.'

"We rode on, and before the surround was made we could see the yellow calves bunched up at one side of the herd. My uncle pointed them out to me, and said: 'Now, when the herd starts, try to get among those calves, and remember all I have told you.'

"At length the soldiers gave the word for the charge' and we all rushed toward the buffalo. They turned to run, and a great dust rose in the air. That day there were many men on fast horses, but my uncle's horse was faster than all; and because I was little and light, he ran through the big buffalo, and was soon close to the calves. When he was running through the buffalo I was frightened, for they seemed so big, and they crowded so on each other, and their horns rattled so as they knocked together, as the herd parted and pushed away on either side, letting me pass through it.

"In only a short time I was running close to a yellow calf. It ran very fast, and for a little while I could not overtake it; but then it seemed to go slower and my horse drew up close to it. I shot an arrow and missed it, then another, and did not miss; the arrow went deep into it, just before the short ribs, and a moment afterward I could see blood coming from the calf's mouth; and I ran on to get another. I did kill another, and then stopped and got down. The herd had passed, and I began to butcher the last calf; and before I had finished my uncle rode up to me and said: 'Well, son, did you kill anything?' I told him I had killed two calves; and we went and looked for the other. He helped me to butcher, and we put the meat and skins of both calves on my horse and then returned to the camp."

The book is illustrated with eight photographs of Indians. These photographs are apposite, and, on this side of the Atlantic, unusual. I think anyone over the age of fourteen would enjoy this book.

P. K. F.

"*Cursed Hebona*" *as* Guaiacum officinale (*or* Lignum vitæ) *in Shakespeare's* Hamlet, I. v. 62. [Reprinted from Proceedings of The Royal Society of Medicine, 1921, Vol. xiv. (Section of the History of Medicine), pp. 23–26.] By MARSHALL MONTGOMERY, M.A., B.Litt. (John Bale, Sons & Danielson, Ltd.)

It will be remembered that in the First Act of *Hamlet*, his father's ghost appears to the hero of the play and tells him how Claudius had poisoned him by pouring "in the porches of my ears" the

"Juice of cursed hebona in a viol."

I quote the version of the line used by Mr. Montgomery, though the more usual version—that adopted from the First Folio edition of 1623—runs:

"With juyce of cursed Hebenon in a Violl."

Shakespeare scholars have for many years been divided over the meaning of the word. One side identifies the word with "Henbane"—a coarse, biennial herb, usually found in marshy land, both in Europe and Northern Asia (the common name given to the British species being "Stinking Nightshade")—whose juice, sometimes used in small quantities as a sedative, antispasmodic, and narcotic, proves fatal when taken in large quantities. One of the strongest supports, which Mr. Montgomery has not mentioned, of this theory is a passage of Pliny (*Nat. Hist.* lib. xxv. cap. 4) in which we are informed that the oil of the seeds of henbane dropped into the ears will injure the understanding. Shakespeare, according to Grey, was well acquainted with Pliny's works through Holland's translation of them. Two other theories, the claims of which Mr. Montgomery outlines, identify "hebona" with [illegible] and the yew respectively.

In this short pamphlet Mr. Montgomery has collected a rich and interesting array of data, chiefly from medical and other writings of the sixteenth century throughout Europe, to add confirmatory evidence to his own theory developed in the *Mod. Lang. Review* (July 1920) that "Hebona . . . is a synonym for *Lignum vitæ* or *pockwood*, as it was often called in the sixteenth century, owing to its frequent use in medicine as a remedy against 'French pocks,' leprosy, and other skin diseases."

Amongst a mass of evidence is included a passage from the autobiography of Benvenuto Cellini, typical for its naïve bravado, in which that great Italian sculptor and metal-worker of the Renaissance narrates how he took *Lignum vitæ* against the orders of his physicians, who told him that it would kill him in a week, and how he dumbfounded them all by making a complete recovery.

Mr. Montgomery's new interpretation of "hebona" is as strongly supported a one as any that have appeared

E. L.

Life of Alfred Newton. By A. F. R. WOLLASTON. With a Preface by SIR ARCHIBALD GEIKIE, O.M. (John Murray, 18*s.*)

This is a "life" that will appeal to naturalists, an appreciative record of a rare, delightful, and uncommon personality, one who exercised a great influence at his university on the present generation of zoologists. It is a revelation that strikes the reader as true to life.

The life of a scientist at one of our great universities is usually a happy one. He has a useful life's work, security of tenure, money enough, and considerable leisure. He is his own master; he may spend his holidays doing his research or in travel. If he likes to go fishing or shooting, to write skits or practise verse, there is no one to stop him. What work he has to do interests him. He is really paid for doing what he likes best to do. He is a man of acknowledged position. He has many correspondents and many outside interests. There are the scientific journals occasionally to be contributed to, and a book on the stocks that some fine day will appear and help matters along. He has daily meetings with men who cannot fail to help him in his work, and the stimulus from contact with the keen and ever-growing body of students of the younger generation. On Thursdays he can usually get up to the meetings of the Royal Society; and there meet his contemporaries. In September there is the British Association . . . and there is always the fresh air.

Professor Newton had a love of nature, and especially of birds, that was life-long. An unfortunate accident crippled him as a boy, and in manhood a second accident compelled him to use permanently two sticks in getting about. This did not prevent his travelling often and widely, but it must have been a serious handicap to one in whose category of good things birds occupied the place assigned to horses and dogs in that of the stranger with the tall white hat and the squint whom David Copperfield met on the Canterbury coach. It accounts in some measure also for his very conservative habits. He went up to Magdalene College, Cambridge, as an undergraduate of nineteen in 1848, and six years later was elected to the Norfolk Travelling Fellowship in Zoology, which enabled him to travel to Lapland, Iceland, and elsewhere, to study birds. His early researches laid the foundation of his fame as one of the greatest ornithologists of the day, and in 1886 he was elected to the professorship of Comparative Anatomy at Cambridge, a post he occupied till his death in 1907.

This book has been written by one of Professor Newton's students, at the moment of writing in Spitsbergen on an expedition, and himself a distinguished zoologist. He has given us a very readable volume. From personal knowledge and by selections from the many letters written to and by Newton, he has described very clearly the principal events in his life, his opinions and his characteristics. Sir A. E. Shipley contributes an admirable chapter of reminiscences, Mr. F. H. H. Guillemard a few pages, and one of Newton's oldest friends, Sir Archibald Geikie, the preface.

Newton was a naturalist from his youth up. There was talk at one time of his going into the Church, but ornithology claimed him. He was never happier than when observing or talking about birds, while his feeling about Orders (though he was a genuinely religious man) was that the nearer he got to them the less he liked their look. In addition to keeping up a lively correspondence with such naturalists as Canon Tristram, Kingsley, and Darwin (some of which is reproduced in this book), and contributing many papers to the scientific journals, he published three works, the best known of which is the *Dictionary of Birds*. He was one of the earliest naturalists in this country to accept Darwin's explanation of the origin of species, and did good work in attempting the herculean task of making that explanation more acceptable by his brethren. In many ways, however, he was old-fashioned and a slave to fixed ideas. Like Mr. Crisparkle's mother, as Dr. Shipley puts it, he was always "open to discussion," but he invariably looked as though he would like to see the discussion that would change *his* mind. He hated changes of all sorts as one should the devil, and both on scientific matters and on little points about which an ordinary man would not worry his head he was extraordinarily conservative. He was, indeed, a mixture of the crusty old bachelor don and the good, old-fashioned, mid-Victorian country gentleman, a race to which by birth he belonged; a man of strongly-marked personality, generous and kindly at times, calm and very able, in all he did painstaking and accurate, yet with a singular lack of sympathy with men and things from whom and which he found occasion to differ. He hated the Radicals, and in his catalogue of aversions were hymns, cats, motor-cars, and the Cambridge trams. He regarded much of the newer work in his own subject as new-fangled, and so averse was he to systems of classifications that in the compilation of his dictionary he fell back upon the alphabetical system. Being accurate himself because he strove to be so, he disliked inaccuracy in others. Consequently he often came down like a hammer on men whose work one would ordinarily allow to pass. For example, he thought there was a uniformly false tone in the writings of Richard Jefferies, which for all their inaccuracy scientifically considered, and lack of original observations, have been very effective in introducing readers to the delights and appreciation of the countryside, and even to-day retain a measure of their original popularity. His relations with publishers were rather amusing. He regarded them all as "scoundrels alike, especially those of the highest repute." The truth really was that Newton was so careful and accurate a writer that he took about five times as long to get out a book as he assured the publisher he would when he began. He edited one series of books so leisurely that the publisher was forced to hand over the completion of the work to others, and the second volume of another serial publication which he had promised for 1864, was not ready—till 1902. There were reasons for the delay, and one cannot but admire a man who refused to rush into print; but anyone, be he publisher or not, who has held his breath successfully for a single minute will agree that thirty-eight years is rather an uncommonly heavy strain on the patience.

It is curious that in lecturing—his one compulsory duty as a professor—Newton was not a conspicuous success. "Newton's lectures," writes Dr. Shipley, "were desperately dry and very formal. He sat before a reading desk and read every word of the discourse from a manuscript, written in his minute hand with a broad quill, so that all the letters looked the same, like the Burmese script. At long intervals there was drawn the outline of a tumbler, like the wine-glasses which used to indicate in the foreign *Bradshaws* those railway stations which boasted the existence of refreshment rooms. Whenever the Professor came to these outlines he religiously took a sip of water. Whether it was the time of day (one to two p.m.), or whether it was that we students were all absorbed in Comparative Embryology and in Morphology, the attendance was always small. I went during my second and third year, and at times was the sole auditor. Not that that made the least difference to the Professor. He steadily and relentlessly read on—'The majority of you now present know,' 'Most of my audience are well aware,' and similar phrases left me in considerable doubt as to what parts of me were 'the majority, and which the 'most.'"

It was in informal talks in his room after lecture or at his house in the old lodge at Magdalene College that the Professor excelled. His rooms, on Sunday evenings, were a meeting-place for the younger men in residence and of older men revisiting Cambridge or returning from expeditions abroad. The influence of these meetings, as many letters in this book testify, was very great. "After a glass, or perhaps two, of port, and a couple of exiguous Russian cigarettes in the Combination Room, the Professor used to retire, and twenty minutes later those who were privileged to dine with him in the Hall went through the garden entrance, and so into the inner room, where we found him seated in an arm-chair just within the doors. The room was plainly but comfortably furnished in the mode of the Victorian period; the fire was very hot, the guests were seated in a large circle of chairs, something like the Christy Minstrels of our boyish days; and yet in spite of these obvious disadvantages Newton's Sunday evenings saved Zoology as the science of living animals in Cambridge. Often there were awkward pauses, but the Professor sat through them all, making paper spills out of old letters, and smoking pipe after pipe. To him the little Russian cigarettes were merely *hors d'œuvre*, the real business was tobacco in a pipe, and he held very strong views about pipe-racks. . . . The Sunday evenings were a little formal and a little dull; we were all a little afraid of the Professor, and much more afraid of ourselves. Sitting in that semicircle of seats it was difficult, if not impossible, to break up into groups, and yet those Sunday evenings and some others which I attended . . . helped me more than I can say. He was in the real and the best sense a man of the world, and hence he was able to help us, and did help us in many ways not in the least zoological."

This book gives a reader an interesting account of the happy life of an honourable, obstinate, truthful, high-spirited, and very genuine man.

A Brief Account of Radio-activity. By PROF. FRANCIS P. VENABLE, D.Sc., LL.D. (Boston: D. C. Heath & Co. London: G. G. Harrap & Co., 3*s* 6*d*.)

This little book, published in 1917, which has just come my way, is the work of the Professor of Chemistry in the University of North Carolina, and is published for the information of the general reader or for those students of science who wish to know something of radio-activity but have not sufficient time or desire to read the larger treatises. It is based on Rutherford's *Radio-active Substances and their Radiations* (Cambridge University Press, 1913) and Soddy's *Chemistry of the Radio-elements* (Longmans, 1915). It is a small book of but fifty pages, and one's first comment on reading the title is "Too brief," yet the matter is set forth so clearly and simply that the brevity is a help and not a hindrance. It is recommended to readers not only for its own merits, but also for the fact that it is the only book in English devoted entirely to Radio-activity that is approximately up-to-date. The lists of the radio-elements given on page 24 need some revision in the light of new elements discovered since 1916, and because of a small change in nomenclature that has been lately adopted. It would be a good thing, I think, if the publisher would issue a correction slip for this page, so that a reader coming to the subject for the first time may have the information as accurate as it is at present known. I think also that authors of little books like this one would do well to give a carefully selected list of books or of scientific articles for further reading. Guidance of this kind is most valuable and is invariably appreciated by the student.

The Case against Spirit Photographs. By C. VINCENT PATRICK and W. WHATELEY SMITH. (Kegan Paul, 2*s*.)

A reprint of an article in the April *Psychic Research Quarterly*. An interesting and important study which was commented on editorially in the June issue of DISCOVERY.

Correspondence

To the Editor of DISCOVERY

SIR,

In the review of *Bibliotheca Chemico-Mathematica* in the July issue of DISCOVERY, A. S. R., referring to a book by Sir Kenelm Digby, writes: "Digby was an interesting type who first described his 'powder of sympathy' in a lecture which was supposed to have been delivered at Montpellier in 1658 . . . quite clearly Digby was an impostor." I have been unable to trace the actual origin of this powder, which, though usually associated with Digby's name, does not appear to have been his discovery. For a book published in 1651—*The History of Generation, to which is joined a discourse of the Cure of Wounds by Sympathy*, by Nathaniel Highmore, the celebrated anatomist and scholar of Trinity College, Oxford—gives a complete account not only of the preparation and application of the powder to the "cruentated cloth," but also of the scientific theory, which was believed by Highmore to account for its undoubtedly beneficial action—the theory of "atomes." Mention is there made of Digby's use of the powder, but it is referred to as "that powder known chiefly by the name of Sir Gilbert Talbot's Powder." It would seem, therefore, that Digby was no impostor, but rather the dupe of the scientific theories of his time.

Yours faithfully,
E. PRIDEAUX.

PSYCHOLOGICAL LABORATORY, CAMBRIDGE.
July 6, 1921.

To the Editor of DISCOVERY

SIR,

The promise made in the first number of DISCOVERY—that the articles would be written by contributors who could speak with authority in their own branch of knowledge—has been so amply fulfilled that it seems the more desirable to call attention to such a departure from that excellent rule as is displayed in Mr. O. G. S. Crawford's article on "Past and Present" in the July number (vol. ii, p. 182). No man, of course, can be an expert on the whole of the past, or the whole of the present; but your readers may fairly expect that the writer of an article with such a title will be speaking with authority upon the subjects from which he thinks fit to draw his examples. In the passage on page 183 relating to the transfer of land, Mr. Crawford makes (either expressly or by necessary implication) the following statements.

1. That the method of transferring land has persisted almost unchanged since A.D. 700.

2. That the Ordnance Maps were prepared for the express purpose of simplifying the procedure of transferring land.

3. That the lawyers, or a section of them, refuse to use the Ordnance Maps for this purpose.

4. That, in their own interests, they smother the business of transferring land under an unintelligible ritual of expensive jargon.

5. That the documents by which land is transferred at the present day are unintelligible and contain jargon.

6. That at one time it was necessary to have Norman blood to be a landlord.

Perhaps you will allow me to add a brief statement of the true facts in each case:

1. The method of transferring land has been radically changed at least three times since Anglo-Saxon times.

2. The Ordnance Maps were originally prepared on the 1-inch scale, for military purposes. In 1841 the 6-inch scale was adopted in order to facilitate the construction of railways in particular and other public works in general, and the ascertainment of boundaries (*Hansard*, 3rd ser., vol. lvi, p. 529). Even this scale was found too small in populous districts, and the larger scales were accordingly approved by Parliament in 1855 (ibid., vol. cxxxi, p. 201; vol. cxxxix, p. 1319). Years afterwards, appeals were made to the Government to expedite the survey, in the interests of land transfer; but the Treasury were hard-hearted.

3. The Ordnance Maps, being more accurate and on a more convenient scale than the old Tithe Maps, are extremely useful in connection with the transfer of land, and are used in ninety-nine cases out of a hundred. But their use could not have, and has not had, the effect of altering the procedure; it has merely reduced the length of the documents to some extent.

4. For nearly forty years it has been practicable for solicitors, without neglecting their clients' interests, to make the transfers of land short and simple in ordinary cases, and for nearly thirty-nine years it has been in the solicitors' own interest to make them short and simple in all cases, with very rare exceptions. Being paid a fixed fee (varying with the amount of the purchase money), a solicitor is merely wasting his own time, paper and ink if he inserts anything unnecessary.

5. Every word in a modern transfer of land is readily intelligible by any person of ordinary mentality who has had a liberal education. There is now before Parliament a Bill, drafted and promoted by lawyers, which removes the necessity of any technical words whatever, and is intended to make the whole process absolutely fool-proof.

6. Anglo-Saxons had become landlords before the Conqueror's death (Freeman's *Norman Conquest*, vol. iv, p. 251).

It may be permissible to refer the seeker after elementary knowledge to Pollock's *Land Laws* for a clear outline of the law relating to land and for a candid account of its defects; and to Digby's *History of the Law of Real Property* for accurate historical information.

Yours faithfully,
NORMAN C. ARMITAGE
(*M.A. Cantab.; Barrister-at-law*).

11 OLD SQUARE,
LINCOLN'S INN, W.C.2.
July 14, 1921.

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Editorial Notes

The question of the relations between art and science has recently been revived in the Press and amongst many groups of thinkers. So far as the Press is concerned, this has been partly due to Viscount Haldane's [1] consideration of the meaning of Reality as applied to art and its meaning as applied to science. With Viscount Haldane's subtle distinctions and definitions we do not intend to concern ourselves here. What we do intend to express in these notes is a more practical attitude to the whole subject—an attitude which regards art and science as supremely important one to the other, and as incomplete one without the other. It is an unfortunate fact that many so-called *educated* people of to-day assume one of these two mistaken views: (*a*) that the growth of science is harmful to art, and is, therefore, a danger to civilisation, or (*b*) that these are the days of science, and that art is out-of-date, inefficient, and useless. Put so bluntly as this, these notions seem absurd, but they are in varying degree held by a number of people, and, should you discuss art and science with many men of moderately able intelligence, you will almost certainly find that one or other of these two biasses lies at the back of their minds.

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The first belief is a comparatively harmless one, for nothing can now stem the progress of science; it is an essential part of our civilisation; moreover, it is easy to prove historically that science, far from driving art into the background, has often lent it inspiration. We need only mention the discoveries of Copernicus and Galileo, which quite definitely played a part in effecting the Renaissance of European art and literature in the fifteenth and sixteenth centuries, and the great movements in English art and literature during the Victorian era, when science began to make such rapid strides forward, in order to prove our point. But the second bias is far more general and far more insidiously dangerous. In an age of science and mechanical invention such as ours, it is easy to relegate art to the background as something possibly pleasant, but undoubtedly useless. Such an attitude is dangerous not only to art, but to science itself, for art in the wider sense is still the life-blood of science. Nearly a hundred years ago one of the greatest of all lyric poets [2] wrote these words:

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"It exceeds all imagination to conceive what would have been the moral condition of the world if neither Dante, Petrarch, Boccaccio, Chaucer, Shakespeare, Calderon, Bacon, nor Milton had ever existed; if Raphael and Michael Angelo had never been born; if the Hebrew poetry had never been translated; if a revival of the study of Greek literature had never taken place; if no monuments of ancient sculpture had been handed down to us; and if the poetry of the religion of the ancient world had been extinguished, together with its belief. The human mind could never, except by the intervention of these excitements, have been awakened to the invention of the grosser sciences, and that application of analytical reasoning to the

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[1] *The Reign of Relativity*. (See list of *Books Received*.)

[2] Shelley in *A Defence of Poetry*.

[illegible] of [illegible], which it is now attempted to exalt over the direct expression of the inventive and creative faculty itself."

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We need not draw any invidious comparisons, as Shelley did in this passage, between science and art. Indeed, they cannot be compared. Both are equally important and, as we have already remarked, either without the other is incomplete. But the main idea of Shelley's magnificent declaration remains true: art is the factor that keeps imagination alive amongst us, and so helps to keep us from becoming morally worthless and intellectually sterile. For it is imagination which quickens the mind of the inventor and researcher, and which drives the explorer into unknown territory. No, in these days, when knowledge is increasing so widely and rapidly, the man of science and the man of art are beginning to realise the value of each other's work. The wider the horizon, the deeper the comradeship.

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In the field of co-ordination of knowledge no less than in accurate observation of nature, men like Fabre[1] and Maeterlinck[2] have done most valuable work, for they have given us in fine prose the results of their minute investigations. Mr. H. J. Massingham[3] has applied the careful methods of observation used by Fabre in his study of insect life to the study of birds. *Some Birds of the Countryside*, a book that I have lately had the good fortune to encounter, is more personally written and somewhat less microscopic in its observations than Fabre's work. It endeavours to show birds as part of the beauty of the universe, and so assign them a place in the system of creation. Most of us have hitherto known Mr. Massingham as the driving-power behind the Plumage Act, but in his introduction to *A Treasury of Seventeenth-Century Verse*,[4] published last year, he showed his worth both as a literary critic and as a worker in research; and he now appears as a writer with a broad outlook and a fine, even if at times a rather self-conscious, style.

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The most entertaining chapter of the book is that devoted to Charles Waterton, a naturalist of the early nineteenth century, chiefly known for his *Wanderings in South America* (1825). Waterton's jottings on natural history are indeed so interspersed with remarks on politics, religion, and history, and by stretches of autobiography, that they are often more entertaining than instructive. Here is a political jotting: "If driven to extremities, I had rather be slain by the sword of a Tory at noonday than be stabbed at midnight by the muck-fork of a sinuous, tortuous, treacherous Whig. . . . Poor Britain! I pity thee from my heart! What with Jew and what with Gentile, thy Parliament House will soon want a Lord Protector with his whitening brush. 'Sir Harry Vane!' The Lord deliver me from Sir Harry Vane!"

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Waterton appears to have gone through a pleasantly adventurous life, according to himself and his Latin-quoting biographer, Dr. Hobson. In his earlier days, for example, he tells us that he strangled boa constrictors in the wilds of Guiana; in latter days we read of him climbing, with his friend Captain Jones, to the head of the guardian angel of the castle of St. Angelo at Rome, "where we stood on one leg"; of a fall from the top of a tree at the age of fifty-eight; of an attempt to fly off the roof of his stables with a pair of self-made wings, from which he was fortunately dissuaded by Dr. Hobson's quotation of the fate of Icarus; and finally of various astounding gymnastic feats in his late seventies. Dr. Hobson tells us the manner in which Waterton in his eightieth year would welcome him "actually dancing down the whole length of the broad walk, occasionally throwing one of his loose slippers from his foot high up in the air above his head and expertly catching it in his hand in its descent," a scene worthy of Alice in Wonderland. Most typical of Waterton's apparent reaction to danger is the following incident: "In 1825 he was in Bruges, when the Belgians were revolting for religious liberty. As the cannon-balls whistled round, he sought shelter at a half-open door. . . . 'Just as I arrived at the threshold a fat old dame shut the door full in my face. "Thank you, old lady," said I; "*Felix quam faciunt aliena pericula cautam.*"' ('Happy she who learns caution from another's danger.')" Well, we can only believe that cannon-balls were not so demoralising as a modern shell!

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In the coming conference on Disarmament to be held in the United States, the actors on whom the greatest attention will be focussed will be the envoys from Japan. We may well imagine that they will assume a firm attitude against naval disarmament, but to predict this as a certainty is a very different matter. From the period of the Russo-Japanese War we have become accustomed to regard the Japanese as a *militaristic* nation and an extremely efficient people quick to take advantage of the intellectual and material characteristics of Western civilisation. But age-long traditions do not pass away in a few decades, and unofficial Japan remains much the same to-day as it has been for the last thousand years. Its people are not imbued with so Prussian a military ardour as might be imagined from journalistic descriptions that have appeared in this country, despite the fact that in war they have shown the world a superb fighting spirit and efficiency. Individually they are a kindly, courteous, and hospitable race, and these virtues are most prominently displayed by the peasants of the countryside, of whom the Rev. Walter Weston gives a description in the present number. This writer has lived the greater part of his life in Japan, and, as the result of many expeditions into the interior, possesses a knowledge, hardly rivalled by any other European, of the subject with which he deals. We hope that his article will clear away some of the journalistic cobwebs about the Japanese that may have gathered in our readers' minds, as they most certainly have in ours.

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[1] Fabre is perhaps best known in this country for his books on *The Hunting Wasps*, *The Mason-Bees*, and *The Life of the Caterpillar*. These and eight other volumes have been translated into English by A. Teixeira de Mattos and are published by Hodder and Stoughton. (8*s*. 6*d*. each.)

[2] *The Life of the Bee*, translated by Alfred Sutro. (Allen & Unwin, 5*s*.)

[3] *Some Birds of the Countryside*, by H. J. Massingham. (See reference under *Books Received*.)

[4] Macmillan and Co.

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Another contributor to the present number is Sir William Bragg, well known both as a delightful lecturer to popular audiences, and as one of the foremost of living investigators in experimental physics. His reputation was established when he was professor of mathematics and physics at the University of Adelaide by his work on α-particles and on γ-rays. He returned to England in 1910 to become professor of physics at Leeds, where his work both on γ-rays and X-rays and the structure of crystals led to extraordinarily fruitful and important results. Later he became professor in London. In 1915 he and Prof. W. L. Bragg, of Manchester, his son, were awarded the Nobel Prize in physics for their work on crystal-structure.

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The British Association is meeting this year at Edinburgh from September 7 to September 14. The following are some of the subjects to be discussed at joint meetings of sections: The Age of the Earth, Langmuir's Atomic Theory, Vocational Training and Tests, the Relation of Genetics to Agriculture, and the Origin of the Scottish People. The popular evening lectures will be given by Prof. C. E. Inglis, of Cambridge, on the Evolution of Cantilever Bridge Construction, and by Prof. W. A. Herdman, of Liverpool, on Oceanography.

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These subjects are all of importance. To Scots the Origin of the Scottish People is a matter of great interest. Vocational Training and Tests, and the Relation of Genetics to Agriculture, are questions which are coming more and more into the public notice, and are of great importance to our intellectual and physical welfare. The age of the earth is an ideal subject for a joint sectional meeting, because there are so many points of view to be tersely expressed and trenchantly criticised. And there is always The Man-With-Some-New-Facts who may come along and induce his audience to add a couple of nothings to the somewhat extended period of time during which this dear old earth of ours has kept going. Chemists and physicists will discuss Langmuir's theory. Dr. Langmuir is an American, well known for his researches in advanced electricity. His theory of the atom is at present regarded as highly ingenious, but somewhat ingenuous and of the bring-it-down-to-the-level-of-the humblest-student type. It will be interesting to see how the theory is received at Edinburgh, and what comes of the discussion. Apropos of this, it was stated recently by a "well-known authority" that the structure of the atom was so large a subject of research that, in spite of the great progress made in the past decade, it would engross the attention of the best workers for twenty-five years more at least.

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Our readers may have noticed the correspondence columns in the August number of our journal. We are not referring to those letters in particular when we say that Discovery, aiming as it does at giving information on all branches of knowledge, is always ready and, indeed, grateful to receive and to publish reasonable criticism and suggestion with regard to any articles that appear in its pages. An actor who does not feel the pulse of his audience risks certain failure; and a paper that will not admit to its columns the views of its readers merits a like fate. Discovery exists for its readers, and it desires their co-operation in its aim of getting at the truth.

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In the October number of Discovery, Professor T. E. Peet, of Liverpool University, will give an account of his recent work on the site of the city of the sun-cult at Tell-el-Amarna (Assiut Province, Upper Egypt), where the Germans did a vast amount of excavating before the war. This immense city was built by Amenhotep IV (1375–1358 B.C.)—a monarch with ideals, who attempted to implant sun-worship as a monotheistic religion in Egypt. Since the war, Professor Peet has carried out considerable researches at Tell-el-Amarna. The editor found him there last March, living in a dwelling reconstructed by the Germans from one of the city's several thousand ruined houses.

Electrons and Ether Waves[1]

By Sir William Bragg, K.B.E., F.R.S.

Nobel Laureate ; Professor of Physics in the University of London, University College

I PROPOSE to ask you to consider for a short time one of the outstanding problems in Physics. I am justified, I think, in saying that so far it has proved insoluble, but for all that, it lacks neither interest nor importance. It is important because it relates to very fundamental things with which we are deeply concerned, and as to its interest, it comes in many ways.

Man's interest in radiation is naturally very old indeed. The warmth of the sun, the light that it gives by day, and the light of the moon and stars by night, fill a first place in their importance to him. When experimental science began to grow rapidly, its first efforts were devoted to an attempt to unravel the laws of propagation of light and heat. Among the famous pioneers Newton and Huyghens represented two opposing schools of thought. The former advocated a corpuscular theory of light, the latter maintained that light consisted of a wave motion. In a restricted sense, the wave theory has completely triumphed ; it explains the ordinary phenomena of light and especially of the intricate effects which depend on interference of waves with the greatest satisfaction and precision. But, on a wider view of light phenomena, the victory of the wave theory is not so absolute, for it is certain that a great part is played by corpuscular radiations, the corpuscles being the electrons of recent discovery. It seems that we must admit the importance of each view and, to a certain extent, we can accurately define the part that each must play : but, there is one great exception. There is one problem in connection with the interrelations of electron waves and corpuscles which seems to ridicule all our attempts to understand it. If we could solve it we should have made an immense advance, both in knowledge and in our power of handling materials. We should perhaps have added a new province to the realms of physical thought. And it is because of this obvious importance and because of our failures to find the solution that I hope you will be interested in looking at the question once again in the light of recently acquired knowledge.

We are going to consider the relations between the energies carried by ether waves and the energy carried by electrons. Let us first set down the distinctive features of each form of radiation. As regards wave radiation, we must say that the energy spreads outwards and weakens as it spreads, just as a sound dies away in the open air. And next we must add that all waves show the extraordinary phenomenon of interference. Two sets of waves can tend to destroy each other's actions at certain places and times, making good such losses by increased actions at other places and other times. By the aid of this principle Young and Fresnel, and a host of workers who have followed them, have built up optical theories of great power and completeness. Note that the characteristics of a simple wave are its length[2] and its amplitude[3] : it has no others.

Corpuscular radiations have been obvious to us on the grand scale only since the discovery of radium and of X-rays. Beside the α-rays, the projection of helium atoms from the bursting atoms of radio-active substances, we find in the general radiation of radio-active substances streams of high-speed electrons. The main features of these rays which concern us now can also be stated briefly :

Electrons are to be found everywhere forming part of every atom. They can be set in motion by electric forces, as in the X-ray tube, or they may be expelled from radio-active substances. Such radiation, like light radiation, has qualities. The flying particles may be more or less in number, and the speed of each can fall between wide limits. In other respects it is, at present, assumed that they are all like each other. We have not been acquainted with electron movements so long as we have been acquainted with wave motions in ether. The reason is perhaps a simple one :

An electron can only maintain a separate existence if it is travelling at an immense rate, from one three-hundredth of the velocity of light upwards, that is to say at least 600 miles a second or thereabouts. Otherwise the electron sticks to the first atom it meets. The action of a powerful induction coil and space to move in freely, where there are no atoms to impede it, provide favourable circumstances for observation, and we have only been able to realise these conditions with sufficient success in more recent years.

We now know, therefore, radiation in two forms, and each is independently full of interest. But it is the extraordinary connection between them that is so fascinating and yet beats us when we try to explain it. We have known for many years that there is some connection between waves and electrons, because light, especially of short wave length, can cause a discharge of negative electricity, that is to say, of electrons, from substances on which it falls. This, which is known as the photo-electric effect, has been carefully examined with a view to discovering the relations between the wave length of the ether radiations and the velocity of the ejected electrons. But the experimental difficulties of obtaining a close insight into the effect were always considerable until we had to do with the new variety of light which Röntgen discovered in 1895. The very short wave length which is associated with X-rays goes with a photo-electric effect which is so greatly intensified that we can examine it in detail, and now the relation between wave and electron takes on an importance which arrests attention.

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[1] This lecture was given in May to the Oxford University Junior Scientific Club, and is here reproduced by their kind permission. It is published in separate form by the Oxford University Press at 1*s*.

[2] The distance between adjacent crests.

[3] The maximum distance from the mean position attained by a vibrating particle.

We can take the question in two stages: in the first as a general question. In the second we bring in effects which depend on details of atomic structure.

The general question can be stated quite simply. We have seen that a wave motion is defined by two qualities. The one the wave length; the other the amplitude. When an X-ray falls upon any material substance we find that electrons are ejected; the wave radiation has produced an electron radiation. Electron radiation has characteristics also, namely, number and speed. In what way, then, are the characteristics of the waves related to the characteristics of the electron movements which are excited by them? The answer is simple but surely unexpected. The velocity of the electron depends on the wave length only; the number of electrons depends on the intensity, but not on the wave length. Moreover, the relation between the wave length of the one radiation and the velocity of the other is of the simplest kind. If we define the wave length by stating the number of waves that pass by a given point in a second and call this number the frequency, then the energy of the electron is equal to the frequency multiplied by a constant quantity. This constant is not new to us, it had already turned up in connection with investigation of interchange of energy, where waves are concerned, and is well known as Planck's constant. That, however, need not concern us now.

The essential point is that a wave radiation falling on matter of any kind whatever and in any physical condition, liquid or solid or gaseous. hot or cold, causes the ejection of electrons. In actual experiment we cannot usually examine the speed of the electron at the instant of its production. We have generally to wait for the electrons to get outside the body in which they arise before we can handle them in our experiments. Those that have come through the deeps of the material have lost speed by collision with the atoms on their way out. Consequently, we have in response to the incidence of waves of a definite frequency, that is to say, of so-called monochromatic radiation, an output of electrons of various speeds ranging downwards from a maximum which is given by the above-mentioned relation. There does not seem to be any doubt that the electrons all had originally quite the same definite speed, and that the differences in speed are acquired subsequently.

In this process we see energy of wave radiation replaced by energy of electron radiation. There is an exactly converse process. If we direct a stream of electrons against any material substance we can call into being ether waves. They arise at the point of impact, and their quality is, in the general sense, determined by the velocity which we have given the electron stream.

Among the waves so originated there are some whose frequency is related to the energy of the individual electron in the electron stream by the same constant as before. There are others of lesser frequency, such as we might suppose to be originated by electrons that belonged to the original stream, but have lost energy by collisions with the atoms of matter. Here, again, there is no doubt that the electrons produce waves for which the frequency is exactly determined by the use of Planck's constant as above.

In order to realise the full significance of these extraordinary results, let us picture the double process as it occurs whenever we use an X-ray bulb. By the imposition of great electrical forces we hurl electrons in a stream across the bulb. One of these electrons, let us say, starts a wave where it falls. This action is quite unaffected by the presence of similar actions in the neighbourhood, so that we can fix our minds upon this one electron and the wave which it alone causes to arise. The wave spreads away, it passes through the walls of the bulb, through the air outside, and somewhere or other in its path, in one of the many atoms it passes over, an electron springs into existence, having the same speed as the original in the X-ray bulb. The equality of the two speeds is not necessary to the significance of this extraordinary effect; it would have been just as wonderful if one speed had only been one-half or one-quarter or any reasonable fraction of the other. The equality is more an indication to us of how to look for an explanation than an additional difficulty to be overcome.

Let me take an analogy. I drop a log of wood into the sea from a height, let us say, of 100 feet. A wave radiates away from where it falls. Here is the corpuscular radiation producing a wave. The wave spreads, its energy is more and more widely distributed, the ripples get less and less in height. At a short distance away, a few hundred yards perhaps, the effect will apparently have disappeared. If the water were perfectly free from viscosity and there were no other causes to fritter away the energy of the waves, they would travel, let us say, 1,000 miles. By which time the height of the ripples would be, as we can readily imagine, extremely small. Then, at some one point on its circumference, the ripple encounters a wooden ship. It may have encountered thousands of ships before that and nothing has happened but in this one particular case the unexpected happens. One of the ship's timbers suddenly flies up in the air to exactly 100 feet, that is to say, if it got clear away from the ship without having to crash through parts of the rigging or something else of the structure. The problem is, where did the energy come from that shot this plank into the air, and why was its velocity so exactly related to that of the plank which was dropped into the water 1,000 miles away? It is this problem that leaves us guessing.

Shall we suppose that there was an explosive charge in the ship ready to go off, and that the ripple pulled the trigger. If we take this line of explanation we have to arrange in some way that there are explosive charges of all varieties of strength, each one ready to go off when the right ripple comes along. The right ripple, it is to be remembered, is the one whose frequency multiplied by the constant factor is equal to the energy set free by the explosion. The ship carries about all these charges at all times, or at least there are a large number of ships each of which carries some of the charges, and externally the ships are exactly alike. Also we have to explain why, if we may drop our analogy and come back to the real thing, the ejected electron tends to start its career in the direction from which the wave came. This is a very marked effect when the waves are very short.

Dropping the analogy, how do the electrons acquire their energy and their direction of movement from waves whose energy and momentum have become infinitesimally small at the spot where they are affected, unless the atom has a mechanism of the most complicated kind? And if the intervention of the atom is so important, why is it that in these effects a consequence of the intervention does not depend upon each atom itself—whether, for example, it is oxygen or copper or lead?

We may try another line of explanation and suppose that the energy is actually transferred by the wave from the one electron to the other. If it is the atom which pulls the trigger and causes the transformation, then how does it happen that the whole of the energy collected by the wave at its origin can be delivered at one spot? Rayleigh has told us that an electron over which a wave is passing can collect the energy from an area round about it whose linear dimensions are of the order of the wave length. But any explanation of this kind is entirely inadequate. Whatever process goes on, it is powerful enough on occasion to transfer the whole of the energy of the one electron to the other. Nor can there be any question of storing up energy for a long period of time until sufficient is acquired for the explosion. For it is not difficult to show that when an X-ray bulb is started and its rays radiate out, the actual amount of energy which can be picked up by an atom a few feet away would not be sufficient for the ejected electron, though the tube were running for months; whereas we find the result to be instantaneous.

I think it is fair to say that in all optical questions concerned with the general distribution of energy from a radiating source the wave theory is clearly a full explanation. It is only when we come to consider the movements of the electrons which both cause waves and are caused by them that we find ourselves at a loss for an explanation. The effects are as if the energy were conveyed from place to place in entities, such as Newton's old corpuscular theory of light provides. This is the problem for which no satisfactory solution has been provided as yet; that, at least, is how it seems to me.

No known theory can be distorted so as to provide even an approximate explanation. There must be some fact of which we are entirely ignorant and whose discovery may revolutionise our views of the relations between waves and ether and matter. For the present we have to work on both theories. On Mondays, Wednesdays, and Fridays we use the wave theory; on Tuesdays, Thursdays, and Saturdays we think in streams of flying energy quanta or corpuscles. That is, after all, a very proper attitude to take. We cannot state the whole truth since we have only partial statements, each covering a portion of the field. When we want to work in any one portion of the field or other, we must take out the right map. Some day we shall piece all the maps together.

Meanwhile, even if we cannot explain the phenomena, we must accept their existence and take account of them in our investigations. We must recognise that wave radiation and electron radiation are in a sense mutually convertible. Whenever there is one there must be the other, provided only there is matter to do the transforming. We do not yet know more than a little of the part that this process of interchange plays, but we know that it is very prominent when the waves are very short, or, what is the same thing, the electrons moving swiftly. It is the movement of the electrons in the X-ray bulb that originates the X-rays themselves. They as waves pass easily through the wall in the tube and through materials outside; their energy finally disappears and is replaced by moving electrons. It is the latter alone that produce directly the effects which we ascribe to X-rays. We may suspect that similar effects to these take place when the waves are long, but the corresponding electron velocities are so small that it is difficult to measure them or observe their effects. Nevertheless, the carrying forward to these regions of experience gained elsewhere has led to extraordinary results, as, for example, in the theories of Bohr regarding the relations between the structure of an atom and the radiation it emits.

I have spoken of the first stage in this examination of the relations between ether waves and electrons. May I now go one step further and bring in certain curious and lately discovered relations between the interchanges and the nature of the atom itself? All that I have said before is mainly independent of atomic nature; I want now to consider certain experimental results which are superimposed upon the former without in the least invalidating them, and which obviously have a first importance on our appreciation of atomic structure.

When an X-ray of given wave length strikes an atom, it may result in the ejection of an electron of equivalent energy as described above. And in such a relation between wave length and energy there can be no trace of any influence of the nature of the atom. But it may sometimes happen that the energy, instead of being handed over or transformed in one complete whole, is transformed in a series of successive stages, and these stages are really characteristic of the atom. Let me give an illustration:

Let us imagine an X-ray of wave length equal to two-tenths of an Angström Unit (100-millionth of a centimetre), such as comes, under ordinary circumstances, from a powerful X-ray bulb. It falls on a silver atom; it may, as in the general process, produce an electron of energy equivalent to itself, but it may also divide up this energy into two parts. One part is characteristic of the silver atom. It is an amount which the silver atom is for some reason especially liable to absorb or develop. It is peculiar to the silver atom, no other atom absorbs just that quantity. Leaving out of account for the moment the balance, let us follow the course of happenings to this particular quantity of energy. It excites in the atom a series of rays characteristic of the atom. These rays are divided into groups characteristic of the atom, but of a general arrangement which is the same for all atoms. It appears that the absorbed energy is divided up between various rays, probably giving rise to one out of each group, and in that ray its whole total is spent.

These rays we now analyse with an X-ray spectrometer[1] using a crystal as our diffraction grating. It is by their use that we have been able to study the architecture of crystals and to find the way in which the atoms, under the influence of their mutual force, arrange themselves in crystalline form.

Going back for a moment to the balance, the difference between the energy characteristic of the original X-ray and that amount of energy which was used up in the way just described, this energy, it appears, is found in the possession of an electron whose velocity can be measured with accuracy. Here we have an extraordinary instance of a partition of energy between wave and electron. We find the action of a wave resulting in the initiation of both electrons and waves, but the simple relation which we had in the general case is only modified to a slight degree. There may be several items instead of one in our balance sheet, but the balance is still good. This action follows just as well as a consequence of the impact of an electron having the necessary energy as it does from the incidence of an X-ray in the way I have described. We should notice in addition that when X-rays or electrons fall short in their associated energy of the amount characteristic of the atoms, there is no result at all, and this is reflected in the fact that neither of them is absorbed in the atom so much as if they were respectively a little higher in frequency or a little greater in velocity.

The curious and essential feature of all this mass of information which I have been trying to put before you in a rough and summary form is the interchangeability of ether waves and electrons. Energy can be transferred from one to another through the agency of matter. The transference is governed by the simplest arithmetical rules. In the exchange it is the frequency of the wave which is to be set against the energy of the electron, and it is just this that makes the greatest puzzle in modern physics. It is the block at one point which is choking the entire traffic, and on which, therefore, all our interests must concentrate.

ADDENDUM[2]

The interchange of energy between wave and electron has recently been examined from a new point of view, with very interesting results. It is well known that each atom can be stimulated under the proper condition to the excitement of X-rays characteristic of the atom. For instance, tin atoms can be made to emit a certain series of "lines" known as the K series, provided that the incident and exciting radiation is, if a wave, of shorter wave length than 0·421 Angström Units; or, if an electron, of the corresponding quantum energy.

The actual measure of the "critical quantum energy" of the wave or the kinetic energy of the electron is
$6{\cdot}55 \times 10^{-27} \times 3 \times 10^{10} \div 0{\cdot}421 \times 10^{-8} = 4{\cdot}67 \times 10^{-8}$ ergs.
When the quantum energy of the exciting radiation exceeds this amount the whole K series is excited; the quantum energies of the principal members of the series are 4·55 and 4·02, the unit being 10^{-8} ergs.

Tin, like other atoms, has other characteristic radiations; in particular, there are certain so-called L series whose quantum energies are about one-eighth of those of the K series; and again, there are M series of still smaller energy, and no doubt others amongst which quanta of visible light are included. It is sufficient for present description to assume that the L series have on the average a critical quantum energy 0·65 and the M series 0·12.

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[1] See DISCOVERY, vol. i, p. 31, for an article on this subject by Professor W. L. Bragg.

[2] The author has added these notes for the benefit of readers who have been studying work on X-rays in some detail.—A. S. R.

Two questions now arise: (1) If the critical energy 4·67 represents, as is natural to assume, an energy given up by the incident radiation to the atom, what becomes of the balance when the radiation 4·55 or alternatively 4·02 is excited in the atom? (2) If the energy of the exciting radiation exceeds 4·67, what becomes of the excess?

The answer to the first appears to be supplied by the observation that $4{\cdot}67 - 4{\cdot}55 = 0{\cdot}12$ (M) and $4{\cdot}67 - 4{\cdot}02 = 0{\cdot}65$ (L).

It seems to be the general rule, verified carefully by Duane (*Physical Review*, December 1920), that the difference between two critical quanta is equal to a wave quantum.

An answer to the second question is given by de Broglie (*Comptes rendus*, March 29, 1921), whose experimental results agree with the hypothesis that the excess of the incident quantum energy over the critical quantum energy appears subsequently as the energy of a high-speed electron. De Broglie examined (with other similar cases) the magnetic spectrum of the electron radiation arising from the incidence of rays characteristic of tungsten upon a tin radiator. The two principal incident radiations had quantum energies 10·62 and 9·40; they were, in fact, the K lines of tungsten. In the magnetic spectrum were found five groups of electrons; one of these had a maximum energy 5·9 which is equal to $10{\cdot}62 - 4{\cdot}67$ within experimental error; the maximum energy of the other was 4·7, which is very nearly $9{\cdot}40 - 4{\cdot}67$.

In this case, then, the difference between the energies of the exciting quantum and of the critical quantum is equal to the maximum energy of a group of electrons which is found in the magnetic spectrum.

Three other groups of electrons were found by de Broglie on his plates. Their maximum energies were 4·4, 3·9, and 3·4. These were to be expected, since the characteristic rays of tin, 4·55 and 4·02, were present, having been excited by the tungsten rays of superior quantum energy, and, in further sequence to the rule just stated, there ought to be electron groups having respectively maximum energies equal to $4{\cdot}55 - 0{\cdot}12 = 4{\cdot}43$, $4{\cdot}55 - 0{\cdot}65 = 3{\cdot}90$, $4{\cdot}02 - 0{\cdot}12 = 3{\cdot}90$, and $4{\cdot}02 - 0{\cdot}65 = 3{\cdot}37$.

Parallel results in the case of X-rays have been obtained by C. D. Ellis, under the direction of Rutherford. They are described in the *Proceedings of the Royal Society*, June 1921.

OUR CONTEMPORARIES

The July *Psyche* (5s.) (the new and more ambitious form of the original *Psychic Research Quarterly*) has some highly interesting articles, notably Major Priestley's account of the psychological difficulties of Antarctic Exploration, illustrated by personal experiences, the paper on "Sleep" by Dr. Hartridge and Mr. Whately Smith, and a note on the "Tudor-Hart Theory of Colour." The last-named article touches on ground where the account of "Revolutionary Movements in Modern Painting" in the August issue of DISCOVERY made a halt. The August *Geographical Journal* contains a first instalment of an account by Mrs. Rosita Forbes of her hazardous journey to the Kufara Oasis. In *Science Progress* for July, Professor Bragg, of Manchester, writes on the dimensions of atoms and molecules, and Dr. Atkins on Natural Indigo.

Rural Japan

By the Rev. Walter Weston, M.A., F.R.G.S.

Late British Chaplain at Yokohama

OF all the poetic titles by which the Japanese in ancient days delighted to designate their beautiful land, the most ancient was that of *Toyo-ashiwara-Mizuho-no-Kuni*—" the fertile reed-clad country rich in grain." In this we have the intimation that from the remotest ages of the national existence it is agriculture that has been the occupation of the majority of the people, and their most fruitful source of livelihood. The sudden emergence of modern Japan from her hermit-like seclusion of former days into the roar and rush of intercourse and competition with the Western world has blinded the eyes of most passing observers to that which forms the real basis of the national prosperity. It is in the country-side that we look upon the most characteristic features of the life of the people, and the traveller can only properly appreciate the real strength of national organisation, and the most attractive aspects of the national character, when he leaves the crowded cities and the beaten tracks of Westernised Japan for the fields and farms of the most intelligent and hospitable peasantry in the world.

In spite of the rapid progress of manufacturing and mining industries in recent years, it is agriculture that still stands first as the greatest means of the wealth and power of the people of Japan. The rural population number 60 per cent. of the whole, and it is they who supply the Empire with nearly all its food and drink, and with the greater part of the raw materials for manufactures. There are now no large landed proprietors, and a feature of agriculture is that it means the tillage of small holdings, not merely by the farmer or the peasant himself, but with the help of sons, wife, daughters, and every member of his household. The land really does belong to him, for the doctrine that all is the property of the Emperor is a mere legal fiction, and it is no wonder, therefore, that the man "on the land" works as few peasantry in the world have ever been known to work. Only about 12 per cent. of the whole area of Japan is cultivable, and even this is not naturally very fertile. It is only made to yield its utmost by the minutest and most careful system of subsoil working, manuring, terracing and irrigation, and these are carried on with a care and thoroughness that almost suggests gardening rather than farming. There is practically no machinery employed, and nearly all the work is done by hand, hoe and spade, helped out at times by the ox or the horse.

It is in the task of their subjugation of the land to the service of man that the best characteristics of the Japanese people have been developed—their boundless patience and perseverance, their intelligence, ingenuity, and self-control, their tough constitutions and temperate habits. Some of the finest fighting men in the army are drawn from the peasant classes—hardy, stolid and entirely unafflicted with nerves. Most of them come from the hill country, and their surroundings have left their impress on their character and habits. It was remarked by British officers during the Russo-Japanese War that, in districts where long marches had to be made over routes chiefly leading along goat-tracks or across pathless gullies and crags, each man having to find his own way and to meet his company again on the other side, it was the native mountaineering habitudes of the lower ranks that led them to take the least inaccessible line of country. In mountain warfare the hill-men among the Japanese infantry displayed—as compared with other infantry—some of the attributes and mobility of cavalry. Moreover, there is something in the open and communistic character of the daily life of the country people (for to them privacy is an unknown condition) that renders them natural and considerate, and promotes a resourcefulness and readiness to help each other that must be experienced to be understood. It is among such as these that one finds human nature most unsophisticated and unspoilt, nor has all that is artificial and materialistic in our vaunted twentieth-century civilisation yet laid a paralysing hand upon that inborn simplicity and courteous bearing which in days gone by did so much to justify the title by which the Japanese delighted that their land should be known—*Kunshi no Koku*—" the Country of Gentlemen."

One of the most striking features of the country-side, to one who wanders out from the crowded life of the great towns, is the extraordinary and minute care with which the hills, rising abruptly as most of them do from the alluvial plains and the seashore, are terraced from base to summit wherever a single ear of rice or corn can be made to grow, the resultant landscape resembling nothing so much as a gigantic chessboard decked in yellows, golds and greens of every shade. A story is told of the diligence so characteristic of these tireless toilers that one farmer terraced *his* little hill-sides into no less than eleven tiers. Then he sat down on the summit to rest and survey in triumph the prospect at his feet. To his dismay he could count but *ten* of the terraces he had shaped. The eleventh was there, but invisible, for he was sitting upon it! What makes these agricultural achievements the more astonishing is the fact that they are attained with the most primitive of instruments, for the peasantry are the most conservative class in the nation. The whole of their agricultural system was borrowed from China nearly two thousand years ago, and has known practically no change; the plough they use is that of the Egyptians of the days of the Pharaohs, and spade, hoe, sickle, harrow and flail differ but little from those of their first instructors. On the other hand, however, the wagon and the wheelbarrow are almost unknown.

Of all the most ancient and popular festivals of Japan, those that are celebrated with the geatest zest and enjoyment invariably belong to the life of the country-side, and form a standing witness to the primeval and paramount significance of agriculture to the entire nation. The so-called " national ones," dealing with alleged historical events, are of official origin, and nearly all quite modern. Their observance is chiefly confined to the large towns, and exercises comparatively slight influence on the popular sentiment or imagination. To the outer world the former are sufficiently unfamiliar and significant to deserve record by way of illustration.

A TYPICAL VILLAGE STREET IN RURAL JAPAN.
The woman is washing her rice cauldron.

One of the earliest in the year is that of Inari-Sama, the Goddess of Food, at whose gaily decorated shrine services of intercession are held on the first day of the second month (old style), i.e. March, on behalf of a fruitful rice-harvest later in the year. Inari-Sama (about whose sex there is some ambiguity), is sometimes spoken of as the Fox-Goddess, and is commonly identified with her servant the fox. In view of the all-importance of rice to the whole nation, it is natural that this divinity should be held in such honour, not to say dread, and we find that these festal gatherings partake of the nature of a combination of communion, eucharist, and love-feast. Papers stamped with the picture of a fox are pasted on cottage doors as charms of exceptional potency. The animal is credited with supernatural powers of bewitchment, and the belief in *Kitsune tsuki*—"Fox-possession"—is very real and widespread. It belongs to a class of folk-lore and superstition of which little is known in this country, and [illegible] it has [illegible] acknowledged by the educated Japanese themselves, though it is of psychological and scientific interest to the student and the medical man.

Japan is one of the most richly watered countries in the world, and as nearly all swift-flowing rivers and impetuous mountain torrents have their own presiding divinities, we are not surprised to find them credited with power to hurt or help the lands through which their waters pass. In districts liable to damage through inundations, services of intercession are held in the third month, our April, and at popular shrines like those of the River Goddess of Kofu, in the broad and fertile plain of Koshu, in central Japan. The goddess is taken out for an airing in her sacred car, and earnest supplications are addressed to her for the protection of the fields and farms of the peasantry in the coming days, when, with the melting of the winter snows, and the storms of early summer and autumn, the myriad mountain torrents swell the parent rivers on their resistless course through the cultivated plains to their wide and populated deltas at the sea.

The month of May sees the country-side under its brightest, busiest, and most varied aspects, and in all its activities nearly everyone, old or young, has his or her part to play. Barley, wheat, and (especially) millet are ripening, and "honourable" tea is now ready to be picked. The grains enumerated are the real staple food of the rural districts, for though all who can live on rice, most of the peasantry, especially in the remoter parts, cannot afford to do so, and only indulge in it on high days and holidays, or in cases of sickness. A friend of mine tells me of an old lady whom he heard remark of a sick neighbour in a country hamlet, with a grave shake of the head, "What! do you mean to say that it has come to giving her rice?" In other words, "The poor thing *must* be in a bad way!"

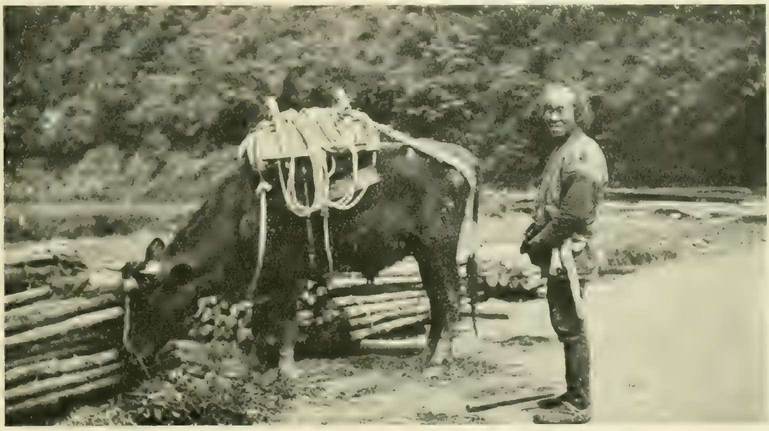
The chief festival of this season is that of the God of Hailstorms, and many an anxious farmer in the silk-producing districts in the great inland provinces of Shinshu and Kofu then visits the ancient village shrine to pray for the preservation of his precious mulberry trees from the dreaded scourge. Strangely enough, however, these are said to be almost immune from lightning, and there is a popular belief that a man caught in the open in a thunderstorm has only to call out "*kuwabara*," i.e. "mulberry grove," in order to surround himself with the prophylactic properties of that valued object and so avert the threatened danger. The Christian Japanese farmer can read with sympathetic interest the story of the plague of hail in Exodus ix, where we learn that "*the flax and the barley was smitten, for the barley was in the ear and the flax was bolled*" (i.e. in bud). Nearly every article of food and domestic utility is committed to the care of its own guardian divinity, and a Japanese writer has observed that, if the interests of the peasantry are not protected by unseen Powers, it is not for want of earnest supplications addressed to them at all seasons and for every possible boon desired.

THE TONEGAWA RIVER IN CENTRAL JAPAN

In the rainy season it is filled with sometimes overwhelming floods.

Of special significance is the festival of the rice harvest, with its twin observances (like those of the ancient Hebrews) of the offering of the First-fruits known as *Kanname-sai*—in the middle of October—with its complement in the *Niiname-sai*—on November 23rd, when the Emperor tastes the new rice that has just been presented at the holiest of all the shrines of Japan

—that of the Imperial Ancestors at Ise—at the climax of the ingathering. The former of these is an essentially popular one, and the best of the precious grain is presented at thousands of village altars throughout the length and breadth of the land. Close by these, on the stages which are usually found at the side of the most ancient shrines and erected for the purpose, a pantomimic dance known as *O Kagura*—" The Seat of the Gods "—is then performed to entertain the guardian divinity in grateful acknowledgment of his kindly care, a thought which is further impressed on the children themselves by the closing of the schools in order to set them free to keep the festival with innocent gaiety. The arrangements which enable neighbouring villages to hold their celebrations on different days, like those in English country parishes at harvest-tide, and so to share their mutual rejoicings, make for a friendly community of interest and neighbourly good feeling.



AN OLD FASHIONED PEASANT ABOUT TO LOAD HIS OX WITH LIGHT TIMBER.
Note the ancient fashion of hair-dressing with the "top-knot."

There is one other festival which is highly popular with the peasantry in late autumn, that of *Ebisu*, the God of honest hard work, as well as of wealth. This is kept with twofold energy, partly because all desire to be rich, and partly because, on the basis of " sympathetic magic," it is felt that one who controls the gift of prosperity should naturally be courted with every sign of merriment and enjoyment of the good things of life. At this festival in the province of Kishu, when the procession bearing the appropriate offerings approaches the shrine, the village head-man calls out in a loud voice, " According to our annual custom let us all laugh," to which exhortation a hearty response is given. The reason given for this is that Ebisu alone, of all the eight million divinities, has not gone to visit the great Shinto shrine in Izumo on the annual holiday sacred to them, for he, being deaf, could not hear the summons thither. And so his worshippers seek to cheer him in his loneliness by their own infectious merriment! It is a natural instinct of the human heart to feel that this act must be acceptable to the Object of its most unfettered rejoicings—" *Let us come before his presence with thanksgiving, and show ourselves glad in him with psalms !* "

It is impossible to get a clear idea of the life of rural Japan until we realise the all-importance of the rice-crop to the nation at large. Two-thirds of the cultivated land is devoted to it and no less than 4,000 varieties are produced, while, as we have seen, it is the sowing, transplanting, and ingathering of it that form the chief occasions of popular solicitude and rejoicing. Until, at the Restoration in 1868, the Daimyo—the old feudal lords—retired into private life, their incomes were paid in rice, and to-day the peasants pay their rent in the same commodity. Only when we have wandered observantly off the beaten tracks and listened to the chance scraps of conversation among the country-folk in the summer months, and heard most of it bearing on the state of the crops and the probable prices ahead, can we appreciate what the precious grain means, even in these days of growing industrialism, to the people of Japan. Japan is not only the third most important rice-producing country in the world, but its rice in quality stands first. In its cultivation all is carried out according to the strictest rule, with a conservatism born of experience. The sowing, for instance, *must* take place on the eighty-eighth day of spring, the first day of which is also New Year's Day. Before sowing the seed is soaked in salt water for a week, washed in fresh water, and then dried, after which it is planted in well watered "nursery" beds. About the end of May it is transplanted into "paddy-fields" in small bunches about a foot apart, an operation employing literally almost millions of men and women knee-deep in water and mud. This is an occasion of great rejoicing, and is celebrated with special songs known as *ta-ue-uta*—"rice-field planting songs." The most momentous period of the whole year, however, comes at the end of August or the beginning of September, when the *ni-hyaku-toka*—the "two hundred and tenth day"—draws near, for it is the ten days which then follow that form the season of intensest anxiety, of mingled hopes and fears, through which the bulk of the population of Japan passes from year to year. The rice is then ripening fast, and it is a gentle breeze that is urgently needed, although it is just at that precise moment that there is usually the gravest peril threatening, in the dreaded typhoon, which not only marks the break-up of summer, but incidentally the breaking-up of much else! With the ripening of the various crops in their proper seasons, and with the birds and countless varieties of insects in which Japan so abounds eager to prey on them, the fields are dotted over with little flags of bamboo and paper inscribed with charms against their depredations. These are called *mushi-yoke*—"vermin dispellers"—and are bought at shrines of repute all over the country.

HARVEST TIME IN THE HILLS

Next in importance to rice come the silk and tea industries, which furnish revenues of some 20 and nearly 5 million pounds sterling respectively, silk being produced mainly in central, and tea in central and southern Japan. There are many features of peculiar interest connected with the cultivation of silk, of which not the least is the treatment of the precious worm itself. It is popularly called *O ko sama*—"the honourable little gentleman"—and during the period of its "intensive cultivation," mainly the month of August, the satisfaction of its voracious appetite keeps whole households occupied day and night, to the exclusion of all else. The leaf-strewn trays, arranged in tiers, fill nearly every room in the house, and the sound of the ceaseless nibbling of the countless myriads is precisely that of the scratching of a thousand pens in the Cambridge University Senate House on an examination day. It is believed that any harsh or noisy, ill-bred conduct on the part of persons within earshot of the little creatures will seriously affect the quality of the silk produced.

Of tea, the national beverage of Japan (drunk always without sugar or milk), we cannot speak in detail. Like most good things in Japan, it was introduced from China about A.D. 800, and for 1,000 years its use was almost confined to the aristocracy and the Court. It is picked after three years' growth of the plant, and is nearly all consumed in the country, with the exception of some fifty million pounds exported to Canada and the United States.

Mention should not be omitted of the part played by the policeman of the country-side as guide, philosopher and friend to all who meet him there on his often lonely beat. Some years ago he was instructed to impress on the good rustics, in their intercourse with European travellers, the following cautions (the unconscious humour lurking therein suggests the person responsible for drafting them did so somewhat feelingly):

"No criticism should be made, either by gesture or words, regarding the language, attire, or actions of foreigners.

"Foreigners are most sensitive regarding cruelty to animals, therefore special attention should be given to this matter.

"When a foreigner pulls out his watch *and looks at it*, you should think that he has business elsewhere, and that it is time for you to leave.

"It is a mistake to suppose that a foreigner will always respond to an application for a loan of money."

On one of my earliest expeditions in the Japanese Alps, I found myself sharing the shelter of a primitive hut with a little rural policeman, whose acquaintance I had made near the mountain foot. At night he insisted on sleeping on the floor beneath my hammock, which I had slung on a convenient beam in the roof. Yet, when I chanced to roll out and land on him somewhat heavily, as he lay snoring peacefully below, his sole comment on this sudden and violent interruption, instantaneously delivered on waking up, was but the politest of apologies—"*O jama wo itashimashita*"—"I am sorry to have been in your honourable way!"

Standards of Correctness in English[1]

By Henry Cecil Wyld, M.A.

Merton Professor of English Language and Literature in the University of Oxford

THOSE who are acquainted with the details of English pronunciation, and the grammar of colloquial speech among good speakers, during the 17th century and the first half, at any rate, of the 18th, cannot fail to be struck by the free and easy character of this period compared with our own day.

The difference may be briefly summed up by saying that at the present time, most speakers who have at least the pretension of elegance and correctness, are, consciously or unconsciously, considerably influenced by the traditional spelling of words, whereas the men and women of the days of Charles II, James II, William III, and Queen Anne did not trouble themselves much about spelling, and certainly did not allow this to influence their speech.

The standard of politeness in uttered speech in the 17th and early 18th century was the traditional practice current in good society, and it is hardly conceivable that anyone in that age whose English would pass muster in what Lord Chesterfield called the 'best companies,' should ever have laid down the law on such matters, as we sometimes hear it done to-day, by saying, "We spell in such and such a way, therefore we ought to pronounce thus or thus." There was, it is true, no lack of learned pedants in the 17th century, especially in the earlier part of it, who applied such tests and recommended people to speak according to their theories of what ought to be, but I cannot find that anyone paid the slightest attention to such vagaries.

It was not until about the middle of the 18th century, so far as I can discover, that there was a serious reaction against the prevailing habits of what we should now consider slipshod, careless, or even vulgar speech.

This reaction was very largely due to the influence of Dr. Johnson, which was exerted *directly* over a wide and distinguished social circle, and *indirectly* through his Dictionary, which was published in 1755.

Certain remarks in this great work gave an authoritative sanction to the small fry of teachers of elocution and obscure writers on the art of good spelling. Henceforth, down to our own time, the process of 'correcting' well-established pronunciations is still going on. Each generation of school teachers sweeps away something of traditional speech and puts something new and strange in its place. It is an interesting fact that these new pronunciations, made according to the supposed intention of the spelling, the history of which is rarely known to the reformers, often gain a footing in circles where a few years ago such things would have been accounted ignorant vulgarisms associated only with the half-educated.

I may mention a few at haphazard that have penetrated during my own lifetime far beyond the sphere of influence of the Primary School. The following are all strange to me and still give me something of a shock: *humour, humorous* pronounced with an initial aspirate; *waistcoat* pronounced like *waist* and *coat*; *Marylebone* pronounced in three syllables with the first element like the name *Mary*, the *le*, and then the last syllable like the word *bone*; *Pall Mall* with both parts rhyming with *shall*; *landscape* with the second syllable rhyming with *shape*; *often* with a *t* in the middle (though we know that as far back as the 16th century Queen Elizabeth omitted it!); *Cirencester* with the first part like *syren* (though 500 years ago *Sissister* or *Sisseter* was established); the suffix *-ham* in place-names like *Birmingham*, etc., often pronounced with an initial *h-*; (does any one pronounce *h* in *exhaust* and *exhibit*, I wonder?); *southern* with the vowel of the first syllable like that in *south*; *Wednesday* with a *d* in the middle (though it had been lost in natural pronunciation at least as early as the 15th century!). Such are a few of the novel pronunciations which occur to me. None of these things were typical of good English in the past; some of them are still regarded as very vulgar; others may be heard from speakers whose English is in other respects free from the vulgarism of sham refinement. This shows that a style of pronunciation, based solely upon spelling, and with no justification from traditional usage, is coming in more and more. The efforts of

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[1] For further reading in this subject the author's recent book, *A History of Modern Colloquial English* (T. Fisher Unwin, 21s.), may be consulted.—ED.

[illegible] to break with tradition and to substitute something which they consider superior have been crowned with no small success in the past, and it seems unlikely that they will be less successful in the future. Very soon English will have lost most of its ancient and reputable traditional pronunciation, and be little else than a modern concoction with nothing behind it. This process of re-creation is being carried out in the name of 'correctness,' of clearness, of reverence for the history of the language (which, as a matter of fact, it sets at nought), upon any and every pretext which suits the taste of the innovators.

It is my intention to set forth some of the ways in which the colloquial English commonly accepted as polite to-day, differs from that of the great age of Dryden, Congreve, Pope, and Swift. Many of the actual words chosen as examples can be shown to have been pronounced as will be indicated several centuries earlier, but I shall, as a rule, confine myself to establishing the pronunciation current among the refined and polite in the 17th and 18th centuries.

It will be seen that our present-day pronunciation, where it differs from that of this earlier period, is due to an attempt to follow the spelling.

It is fair to Dr. Johnson to quote his own words on pronunciation which have already been referred to. There is no evidence known to me that this great man, either in his practice or in his precepts, would have supported the complete break with tradition which has come about since his day. On the contrary, we know that he was careful to ascertain what was the prevalent custom with regard to words about which there was any doubt. Further, had Johnson himself habitually adopted any fantastical or pedantic modes of pronunciation, we should hardly have been left uninformed of them by Boswell.[1]

This is what Johnson says about English pronunciation: "Most writers of English Grammars have given long tables of words pronounced otherwise than they are written, and seem not sufficiently to have considered that of English, as of all living tongues, there is a double pronunciation, one cursory and colloquial, the other regular and solemn. The cursory pronunciation is always vague and uncertain, being made different in different mouths, by negligence, unskilfulness, and affectation. The solemn pronunciation, though by no means immutable and permanent, is yet always less remote from the orthography, and less liable to capricious innovation."

"For pronunciation the best general rule is, to consider those the most elegant speakers who deviate least from the written words."

Here we have a very temperate and pregnant statement. It will be noted that Johnson refers to the 'solemn' pronunciation as 'less liable to capricious innovation' than the 'colloquial.' Could he have foreseen the length to which those who came after him would go in the direction of innovation, we may well doubt whether he would not have qualified somewhat his rule whereby the most elegant speakers might be recognised.

(*To be continued and concluded in the October number.*)

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The Life-History of the Stars

By the Rev. Hector Macpherson, M.A., F.R.A.S., F.R.S.E.

THE idea of evolution in connection with the stars dates only from the beginning of the nineteenth century. Sagacious guesses as regards the origin of the universe had, of course, been made from time to time; and Kent in the middle, and Laplace at the close, of the eighteenth century, had outlined theoretically the possible course of development through which our own Solar System had passed. But it was not until the beginning of the ninteenth century that Herschel, as a result of his long-continued study of the nebulæ, familiarised the scientific world with the idea that stars had developed in the course of ages from matter in a nebulous state.

In his paper read before the Royal Society in 1811 Herschel gave a list of all the nebulæ which he had discovered and studied, "assorting them into as many classes as will be required to produce the most gradual affinity between the individuals contained in any one class with those contained in that which precedes and that which follows it." He traced a probable evolutionary sequence from extensive diffused nebulosities through irregular nebulæ, "nebulæ a little brighter in the middle" and "much brighter in the middle," to planetary nebulæ and nebulæ "nearly approaching to the appearance of stars." He expressed the view that "every succeeding stage of the nebulous matter is the result of the action of gravitation upon it while in a foregoing one, and by such steps the successive condensation of it has been brought up to the planetary condition. From this the transit to the stellar form requires but a very small additional condensation of the nebulous matter." Herschel's nebular theory, which seemed for a time to have been refuted by the resolution of many nebulæ into closely-compressed clusters of stars, was triumphantly vindicated by the dramatic discovery made by the late Sir William Huggins in 1864. In that year the newly-invented spectroscope revealed to Huggins the actual existence of the "shining fluid" which many had been inclined to dismiss as a figment of Herschel's imagination. And with the detection of genuinely gaseous nebulæ, the concept of stellar evolution was finally rehabilitated.

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[1] As a matter of fact Boswell mentions that the people of Lichfield, who, Johnson declared, spoke the purest English, pronounced *there* so as to rhyme with *fear* instead of with *fair*, and *once* as "*woonse* instead of *wunse* or *wonse*." He adds: "Johnson himself never got entirely free of these provincial accents."

The reinforcement of the telescope by the spectroscope enabled the later nineteenth-century astronomers to do what had been beyond the power of Herschel—to classify the stars according to their physical condition. Secchi, the Italian astronomer, made in the sixties his epoch-making survey of the spectra of the brighter stars, as a result of which he divided them into four general types—white stars, yellow stars, and two classes of red stars. At first this classification was regarded as more or less empirical and arbitrary, but latterly Secchi came to the view that it "represented real physical conditions varied by the temperatures prevailing on the different stars." In 1865 the German astronomer Zöllner, of Leipzig, casually suggested that yellow and red stars were simply white stars in different stages of cooling, and this idea formed the basis of the elaborate classification of the stars which we owe to his distinguished pupil Vogel, afterwards of Potsdam. "A rational classification of the stars according to their spectra," Vogel wrote in 1874, "is probably only to be obtained by proceeding from the standpoint that the phase of development of the particular body is in general mirrored in its spectrum." Vogel retained the general framework of Secchi's classification, holding that the white stars, such as Sirius and Rigel, were the hottest and youngest stars, yellow stars such as the Sun and Capella being obviously older and cooler. He viewed the red stars as still older and much cooler, as "effete suns hastening rapidly down the road to final extinction." Vogel revised his classification in 1895, in order to make room for the newly-discovered group of blue or helium stars, which he considered to be still hotter and more immature than the suns of the Sirian variety. In the main, Vogel's scheme and its underlying evolutionary assumption was adopted by Huggins, and formed the basis of the elaborate "Draper classification," carried through at Harvard, U.S.A., under the direction of the late Professor E. C. Pickering. This classification is based on the observed spectral lines, and is at the present time in general use. In this scheme, the various classes of stars are designated by the letters OBAFGKMN—types O, B, and A corresponding roughly to the Sirian type, F, G, and K to the solar type, and M and N to the two classes of red stars. This sequence, OBAFGKMN, was, until about ten years ago, believed by the great majority of astronomers to represent the order of stellar evolution. The association of the early-type stars with nebulæ was strongly confirmatory of this assumption. In 1910 came the discovery, independently announced by Professor Kapteyn, of Groningen, and Professor Campbell, of the Lick Observatory, that the average radial velocities of stars of the later types were greater than those of the earlier types. This was believed to be the final confirmation of the Harvard order of evolution.

There had been, however, grave doubts in certain quarters as to the accuracy of the generally accepted theory. Ritter, of Aix-la-Chapelle, for instance, had regarded the red stars as composed of two separate groups, stars increasing and stars decreasing in temperature. This view was adopted by the late Sir Norman Lockyer, who placed stars of Secchi's third type on the ascending scale, and stars of the fourth on the descending. He also recognised two groups of solar stars, and looked on the white stars not as the youngest orbs, but as stars in their prime. Lockyer's views met with little acceptance at the time, probably because of their association with his meteoritic hypothesis of cosmogony. It was not until the beginning of the present century that serious doubts began to enter the minds of most astronomers. At length, in 1912, Mr. R. T. A. Innes, the director of the Union Observatory in Johannesburg, suggested that the true evolutionary order is the reverse of the Harvard sequence.

In 1905 Hertzsprung, of Potsdam, pointed out that the stars appeared to belong to one or other of two well-defined classes—large diffuse stars and comparatively small stars of greater density. To these two classes he gave the names of "giants" and "dwarfs." This discovery was made independently by Professor H. N. Russell, now director of the Princeton Observatory, New Jersey. From data concerning the masses and brightness of the stars compiled in the course of investigations of stellar parallax, Russell recognised the existence of giants and dwarfs among the red stars. "There are," he wrote in December 1913, "two great classes of stars—the one of great brightness averaging, [illegible] hundred times as bright as the Sun and varying little in brightness from one class of spectrum to another; the other of smaller brightness, which falls off rapidly with increasing redness."

Obviously the existence of these two types of stars was difficult to account for on the generally accepted theory of stellar evolution; it seemed remarkable that there should be some red stars large and diffuse and others small and dense, if all red stars were to be regarded as "effete suns hastening rapidly down the road to final extinction," as Vogel believed. Later came Dr. Harlow Shapley's work on eclipsing binary stars. His investigations brought out the surprising result that some stars of the second or solar type were less dense than some stars of the first. Manifestly this result contradicted the accepted hypothesis on which all second-type stars were considered to be older, and therefore denser, than stars of the first class.

Accordingly, Professor Russell was driven to put forward a new theory, or, rather, to revive Lockyer's hypothesis, considerably modified. "The order of increasing density," said Russell, "is the order of advancing evolution. . . . The giant stars, then, represent successive changes in the heating up of a body and must be more primitive the redder they are; the dwarf stars represent successive stages in its later cooling, and the redder of these are the furthest advanced." The sequence of evolution, then, begins and ends with Class M, and Class B—the helium type—occupies the middle place. The B or helium stars are on the crest of the evolutionary curve, at the meridian of stellar life.

Thus, on Russell's theory, a star in its earlier stages is of great volume, and comparatively low temperature —about 3,000° C.—and its density is almost incredibly low —$\frac{1}{25,000}$ of the density of the Sun. As the star contracts, it grows hotter and denser. The brightness, however, remains more or less constant, the shrinking area being just about compensated for by the increasing surface-brightness. This process of contraction, accompanied by increase of temperature, goes on until the star reaches the B stage, when its temperature is about 20,000° C. and it shines with a blue light. After this stage is reached and the star attains a certain density, it falls off rapidly in temperature, and becomes a cooling dwarf. It is at first a star of the Sirian and next of the Solar type, and then finally is transformed into a feebly luminous star. According to this theory, then, our Sun is a fairly large dwarf star, of decreasing brightness and temperature.

In putting forward his hypothesis, Professor Russell pointed out that the relative scarcity of the B stars—the giants of maximum temperature—is to be accounted for by the fact that only stars of very large mass are able to attain to the high temperature of the B type stars. "Only these stars would pass through the whole series of the spectral classes from M to B and back again in the course of their evolution. Less massive bodies would not reach a higher temperature than that corresponding to a spectrum of Class A, those still less massive would not get above Class F, and so on." "It is now easy to understand why there is no evidence of the existence of luminous stars of mass less then one-tenth that of the Sun. Smaller bodies presumably do not rise, at maximum, to a temperature high enough to enable them to shine perceptibly from the stellar standpoint, and hence we do not see them. The fact that Jupiter and Saturn are dark, though of a density comparable to that of many of the dwarf stars, confirms this view."

When the theory was first promulgated, the difficulties in the way of its acceptance seemed insuperable. In 1915 Professor Eddington pointed out that "it plays havoc with a great deal that has hitherto seemed orderly and intelligible," and he specified the progression of average velocity from the earlier to the later types. This objection, however, has not the force which it possessed six years ago. The work of Eddington himself, and of Kapteyn, Adams, and others indicates that the increase of velocity with spectral type is simply a particular manifestation of a wider generalisation, namely, the increase of speed with diminishing absolute magnitude, and probably, therefore, with mass. Russell's words in 1914 have certainly been justified by the progress of research: "A correlation of mass and velocity . . . seems more probable than one between temperature and velocity, or velocity and age."

Perhaps no new hypothesis in the whole history of astronomical science has been so signally and decisively confirmed within a few years as the evolutionary theory of Professor Russell. First of all, the work of Hertzsprung indicated that even among the "early types" two classes of stars were probably to be distinguished. Striking confirmation was obtained by Dr. W. S. Adams in the course of his determinations of stellar parallaxes by the new spectroscopic method at Mount Wilson Observatory. In 1916 Adams announced that "two groups of M stars are indicated clearly by an examination of the intensities of the hydrogen lines: in the first the hydrogen lines are very strong; in the second they are very faint. . . . Connecting links over a range of seven magnitudes are entirely lacking." At the same observatory, Dr. Harlow Shapley, now of Harvard, discovered in the distant star-clusters red and yellow stars which, to be visible at such vast distances from our system, must be giants. He also noticed that in some of the clusters the brightest stars were red, a result which is explicable only on Russell's theory.

Perhaps the most striking of all the pieces of evidence is the information which had been gained as to the actual sizes of certain stars during the past few years. In 1916 two very faint stars of rapid proper motion were discovered, one by Professor Barnard at the Yerkes Observatory, and the other by Mr. Innes in South Africa. The small star in Ophiuchus detected by Barnard proved to be one of the Sun's nearer neighbours in space, its parallax being easily measurable. The luminosity of this small red star appears to be only $\frac{1}{2.000}$ of that of the Sun, and its diameter three-ninths. Mr. Innes' star—still nearer to our system—appears to be about the same luminosity and size. "It is," Dr. A. D. C. Crommelin has pointed out, "in all probability very near the end of its career as a star, and an opaque crust may be expected to form over its surface comparatively soon." These stars, then, are indisputably dwarfs.

A still more striking piece of confirmatory evidence was obtained in December of last year. In the course of his address at the British Association in August 1920, Professor Eddington, adopting the theory of Professor Russell, made an estimate of the probable angular diameters[1] of some of the brighter stars. "The star with the greatest apparent diameter is almost certainly Betelgeux, diameter 0·051." On the night of December 13, Messrs. Pease and Anderson succeeded in measuring the diameter of this star by means of the new interferometer attached to the great 100-inch reflector. The angular diameter of Betelgeux—the first stellar diameter ever directly measured—came out at 0·045. The parallax is known with some degree of accuracy, and from this the actual size of the star can be computed. The diameter appears to be not less than 273,000,000 miles, and the volume about 27,000,000 times that of the Sun. The existence of giant stars is, therefore, no longer a matter of theory; and Professor Russell's hypothesis has been triumphantly vindicated by observation. More recently the diameter of Arcturus has been measured. The angular diameter is 0·012, in close accord with Eddington's estimate; and the linear diameter is about 19,000,000 miles, just its theoretical size according to the theory of Russell.

In presenting the Gold Medal of the Royal Astronomical Society to Professor Russell, in February 1921, Professor Alfred Fowler remarked that the theory "has the great merit of simplicity and it violates no known physical laws. Russell has led us step by step from the simple conception of giant stars to a consistent explanation of a multitude of phenomena, so that the scope of the theory has become almost as wide as the universe itself." This is eminently true, yet the hypothesis, while solving a multitude of problems, has opened, or rather reopened, several others. What, it may be asked, are the place and function of the nebulæ according to this outline of the sequence of the stellar evolution? Russell's theory begins with the great diffuse red giants, and this stage he takes to be the earliest stage in stellar life. It so happens that the nebulæ, which since Herschel's time have been almost universally regarded as the primeval world-stuff, are usually to be seen in association with white and blue, not red, stars. In the decisive words of Professor Campbell, "Nebulæ and red stars do not coexist. . . . If you find a red or yellow star of normal type, do not look for a nebula in apparent contact with it." The problem is still further complicated by the fact that the Wolf-Rayet stars, a rare class akin to the B stars, are closely related to nebulæ, and that in many cases the nuclei of planetary nebulæ are actually Wolf-Rayet stars. Many temporary stars, too, in the later stages of their history pass through a nebular and then a Wolf-Rayet stage.

Professor Russell would seem to incline to the view that the irregular gaseous nebulæ are not the progenitors, but the products, of the hot B type stars. It may be that these intensely hot gaseous masses, expelled from the stars at their period of greatest heat and activity, ultimately develop into planetary systems, but if Professor Russell's theory is the true one, they are not the parents of stars. The stars would appear to be vastly older than the gaseous nebulæ. Recent investigation has, however, indicated the existence of vast masses of dark nebulosity, particularly in the vicinity of the galactic zone. This dark nebulous material was first disclosed by the photographs of Professor Max Wolf; and latterly Professor Barnard has discovered a large number of these "dark patches" and has, indeed, compiled a catalogue of them. Apparently, if Russell's theory be the true one, these dark nebulæ and not the bright, glowing gaseous masses, such as that in Orion, constitute the primeval chaos from which the stars are born.

Another problem which has not yet been fully solved is the place occupied by temporary stars in the scheme of things. Time was when the appearance of a new star was a rare phenomenon. A hundred years ago, only about half a dozen authentic instances of the appearance of new stars had been recorded in the course of astronomical history. Within recent years, however, owing to the closer watch kept on the heavens, and the large number of celestial photographs which are secured at the different observatories, many of these "novæ" are now known to have appeared, and several are usually detected in the course of a single year. The spectroscopic study of the brighter members of this class has shown that, after the initial outburst which gives rise to a temporary star, a certain sequence is usually followed. After the appearance of a bright-its spectrum the lines [illegible] of nebulæ come into prominence. The new star, in fact, appears to be transformed into a nebula in the later stages of its decline; while, at a still later stage, the spectrum becomes similar to that of the Wolf-Rayet stars. Thus, in 1902, Pickering found the spectrum of Nova Persei to be nebular; five years later, Hartmann at Göttingen discovered that the spectrum was essentially identical with that of a Wolf-Rayet star. Some years ago, the spectra of four novæ were closely studied by Messrs. Adams and Pease at Mount Wilson. By July 1914 they noticed that the two oldest, Nova Aurigæ and Nova Persei, had become Wolf-Rayet stars, and by April 1915 Nova Lacertæ and Novæ Geminorum had become similarly transformed. In connection with this discovery Adams and Pease remarked that "this identity of spectrum, taken in connection with the well-known agreement of distribution, relative to the Milky Way, of novæ and Wolf-Rayet stars, makes it probable that at least a portion of the latter are Wolf-Rayet stars in the later stages of their history."

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[1] The angle (in seconds) which the diameter subtends at the earth

The recent work of Mr. Van Maanen, the distinguished Dutch astronomer, has shown that a number of the Wolf-Rayet stars which form the nuclei of planetary nebulæ are of feeble absolute magnitude and, therefore, presumably of small mass. This fact is difficult to reconcile with the order of stellar evolution as sketched by Russell, and would suggest that there is an alternative path of evolution, and that some, at least, of the dwarf stars, especially those abnormal stars of which a few have been found in recent years, have developed out of planetary nebulæ, which in their turn have been the products of celestial catastrophes, either of collisions between two or three feebly luminous stars, or of encounters of stars with nebulous matter. Russell's hypothesis, however, accounts for the physical condition, brightness, volume, and mass of the overwhelming majority of the stellar bodies, and at present holds the field against all other cosmogonic theories.

What of the time-scale of stellar evolution? The periods of time required for the stars to pass through their various stages appear to be so enormous that in trying to conceive them—to quote Horace Walpole's dictum in regard to the work of Herschel—"one's imagination cracks." Dr. Shapley's study of the stars in the nearer clusters, 20,000 light-years[1] away, and those in the most distant systems, 220,000 light-years removed from our earth, has shown that the stars in the one cluster seem to be at the same stage of development as the stars in the other, which indicates that 200,000 years is a negligible quantity in the life of a star—a mere tick of the clock. Recent studies of stellar evolution abundantly confirm the geological estimates of the vast age of the earth. Periods of thousands of millions of years are not extravagant estimates of the age of our own world. What, then, must be the age of the Sun? How many tens or hundreds of thousands of millions of years have elapsed since the Sun was a red giant, flickering feebly for the first time out of the dim night of the primeval chaos?

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[1] A light-year is the distance travelled by light in one year. About 5,860,000,000,000 miles.

The Roman Calendar

By W. R. Halliday, B.A., B.Litt.

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It is, curiously, seldom that familiar words in ordinary use convey the associations of their literal meaning, and while many readers are probably aware, if they stop to consider it, that September means "the seventh month," few probably have noticed the anomaly of calling the ninth month of the year by this name.

The calendar month is, of course, part of the heritage bequeathed by the Roman Empire to European civilisation. At first sight, however, the problem is no nearer solution, for the Roman Empire, too, began its official year upon January the first. Earlier, when Rome was still a republic, at any rate after 153 B.C., it was upon the first of January that the two consuls, the annually appointed magistrates who constituted the chief executive of the State, entered upon their duties. But as the names of our months still testify, the Roman year had originally begun in March, the month of spring, "when winter's rains and ruins are over," when the citizen-farmer looked forward to the agricultural prospects of the year, and the State to the needs of the summer campaign. Appropriately this is the month of Mars, who was both the god of husbandry and the god of war. There follow April, "the month in which things open," May, "the month of growing," and June, "the month of ripening." July and August owe their present names to Julius Cæsar and Augustus; originally they were called Quintilis, the fifth, and Sextilis, the sixth month respectively. September, October, November, and December are similarly numerical names. January, when the days begin to lengthen and the sun, after the winter solstice, enters upon a new course, takes its name from Janus, the god of doors or openings. Februum means an instrument of purification, and February, the last month of the year, is the month of expiation and purification, the Lent of the Roman year. The purpose with which the calendar was first formulated was a religious one. Throughout their history the Romans displayed a very strong legal sense, and this trait is markedly present in their religious conceptions, which are of a contractual character. The early Roman believed that the divine powers would treat him in exact requital of his treatment of them. If he rendered them their due at the right time and in the right manner, they would be bound to repay him with the appropriate blessing. On the other hand, any sin of commission or omission, whether due to accident or design, would inevitably have disastrous results for him and for the community to which he belonged. It was therefore of the first importance, both for the State and for its individual members, that the spiritual experts, the aristocratic college of *pontifices* who administered religious law, should make it known upon what days religious acts should be performed, and upon what days it was permissible or not to transact the ordinary business of life without offence to the divine powers.

In constructing their calendar, the experts had a difficult task. Anyone who has interested himself in vulgar superstition or in the beliefs of the backward races will realise that the most obvious division of time longer than the day is provided by the lunar month. It is easily to be observed and calculated, and with its periodicity the recurrence of various remarkable physiological and natural phenomena corresponds. But while the lunar month is an obvious starting-point, most inconveniently it refuses to harmonise with the solar year. For a people, however, whose interests were primarily agricultural and pastoral, the observance of the solar seasons was essential. Clearly a system would not work if in time it might involve the religious rites appropriate for sowing being performed at a date when actually the harvest was being garnered. The earlier calendar at Rome, which consisted of 355 days divided into 12 lunar months, in fact proved unworkable because it thus fell out of harmony with the seasons. In 450 B.C. the Romans therefore adopted a Greek system which worked by a cycle of four years. Of these the first and third remained at 355 days, to the second were added 22 days and to the fourth 23 days. In each case the additional days were inserted after February 23. This was a good deal better than the old system. Instead of falling annually short of the solar year by 10¼ days, the calendar was now 4 days in excess every four years. There was still, however, this discrepancy which was arbitrarily adjusted from time to time by the priestly college, who increased the confusion by abusing their power of proclaiming an addition to the number of days in the year for the political purposes of the moment. The question of adding days to the year was, in fact, decided not by the needs of the calendar, but upon such considerations as whether the political wire-pullers wished to postpone an event or to protract the tenure of office of a particular individual by the additional days.[1] The result was naturally chaos, and, when Julius Cæsar took the calendar in hand, it had lost all relation to the seasons, and was more than two months out of the true reckoning. In 45 B.C. Julius adjusted the error and established the year of 365 days with an additional day every four years, the system which, with one further adjustment in Western Europe, is in force to-day.[2]

The schoolboy learns in his Latin grammar that Roman dates are determined by their relation to one of three fixed points in the month, viz. the Kalends, Nones, and Ides. Of these, he is told that the Kalends are the first of the month, that—

" March, July, October, May,
Make Nones the seventh, Ides the fifteenth day"—

and that in the other months the Nones fall upon the fifth and the Ides upon the thirteenth. These three fixed points represent the new moon, the first quarter and the full moon. Upon the Kalends the *pontifices* announced the date of the Nones for that month, and upon the Nones, the first quarter, the religious festivals for the month were publicly proclaimed. With one exception, there were no festivals between the Kalends and the Nones in any month.

A further small point may be noticed. The Romans considered that the odd numbers were lucky, and the even unlucky. In consequence religious festivals fall upon the odd days of the month. Where there is a consecutive group of festivals the even days are left blank between them, and even a single festival which lasts more than one day may be held, not concurrently, but upon every other day. For example, the Lemuria were celebrated upon the 9th, 11th, and 13th of May. Before the reformed calendar of Julius Cæsar, all the months with the exception of February, the unlucky month, contained an odd number of days.

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[1] For an example reference may be made to Cicero's Letters, *Ad Fam.* viii. 6, of which a translation is given in Jean's *Life and Letters of Cicero*, No. 35. Cicero himself was interested, as the addition would have involved the prolongation of his provincial governorship, which he was far from desiring.

[2] The adjustment made in England, though not without some popular opposition, in A.D. 1725 corrected the existing error, and provided that the century years should not count as Leap Years. Eastern Europe has retained the Julian calendar unaltered.

Originally the knowledge of the calendar, like that of all religious law, was the monopoly of the aristocratic college of priests, but inevitably, in course of time, announcement was supplemented by publication. In 304 B.C. for the first time the calendar was exhibited in the market-place, and in 189 B.C. one of the consuls adorned the temple of Hercules and the Muses with a permanent record of the dates of the regular festivals. After the adjustment of Julius Cæsar, the reformed calendar was copied and set up in Rome and elsewhere, and thanks to the survival of a number of fragments of these inscriptions, we possess the Roman calendar practically complete.

This document, though itself of imperial date, throws the most valuable light upon the early Roman religion. As Rome became a cosmopolitan city, Roman religion had been permeated with foreign influences. Roman mythology, like Roman literature, was Greek in origin, and in the literary sources for the study of Roman religion it is often impossible to disentangle what is genuinely Roman. But thanks to the conservatism of Roman official documents, these inscriptions enable us to recover the general outline of the public worship of early Rome with absolute certainty. For in these calendars the old native festivals are written in large capitals, and so distinguished from the later accretions to the ceremonies of the religious year. The information given by the calendar is, of course, similar to that originally proclaimed each month by the religious authorities. It enables the ordinary man to know when, without offence, he may proceed with political or other secular business, and upon what dates he should perform religious duties. The first column divides the days into the purely secular week of eight days from market-day to market-day.

Although market-days provided schoolboys with a holiday, they appear to have had no religious significance. In another column, against each day is set a symbol to show whether religious law allowed the meeting of political assemblies or the transaction of ordinary secular business. Most of the older religious festivals involved complete abstinence from secular business, particularly those which were concerned with the dead or the powers of earth. There were a few cases where the day was divided between religion and business, and affairs might be transacted when the religious ceremonies had finished. There were other days which, for various reasons, were "unlucky." Out of the 365 days, 239 were marked as available for the transaction of secular business; upon the remaining 126 it was wholly or partially prohibited. Further, as we have already noticed, the calendars set out the major festivals of the early Republic in large capitals, while minor festivals, movable feasts, festivals which had been adopted by Rome under foreign influences, and, in some examples, valuable explanatory notes, are inscribed in a smaller lettering.

The nature of the older festivals brings us back to our starting-point, the religious calendar of a people interested primarily in agriculture and flocks and herds, which begins in March and ends with February, the month to which we still add the extra day in Leap Years. The break in the religious ceremonies is between those of February, which look backwards to the past year and its dead, and those of March, which look forward to the promise of the coming year. Throughout the year the festivals reflect the seasonal preoccupations of the farmer. The god of March represented the quickening power of spring, first manifest in his month. The leaping dance of his armed priests has been explained as a magical leaping to make the crops grow high. The clashing of their shields and spears which accompanied the dance may have served the double purpose of frightening away evil influences and of thunder-making by sympathetic magic. March, too, marks the opening of the campaigning season, when the arms and military trumpets were ceremonially purified against their coming use. Early in April a sacrifice of pregnant cows took place. Their calves were burned and the ashes used for fertility "medicine" in the shepherd's festival, which fell a few days later. In this month, too, sacrifices were performed to keep the mildew from the crop. May was marked by a festival of placation of the possibly malevolent ghosts of the dead, and in every household the father "redeemed" the family with black beans, which he spat out of his mouth nine times without looking back, and sent to their place such ghosts as were haunting the house. In May, too, certain human images made of wickerwork were cast into the river, a magical rite the object of which was probably to provide sufficient rain for the crops. And in this month took place the Ambarvalia, the festival which was perpetuated by the Catholic Church in the Rogation processions, and which still survives in some parishes in England in the yearly "beating of the bounds." The object, in the words of Cato's prayer, was to "keep, avert, and turn from us all disease, seen or unseen, all desolation, ruin, damage, and unseasonable influence; to give increase to the fruits, the corn, the vines, and the plantations, and to bring them to a prosperous issue." In June the Temple of Vesta, the sacred hearth and storehouse of the State, was purified; the agricultural significance of the ceremony was the purification and preparation of the storehouse against the harvest of the now ripening corn. July in Italy is a month of heat and drought. Two of the older festivals belonging to the month seem to have to do with deities of water, but their details are very obscure. In August the harvest was safely in, and the month is marked by a series of harvest-home celebrations. September is unimportant from a religious point of view, but October concludes the agricultural process of the year with the ceremonial tasting of the new wine and the strange fertility-sacrifice of the October horse. The summer campaigning season, too, had now come to an end, and a purification of arms took place complementary to that of the beginning of the military year in March. November was a month of hard work, of ploughing and sowing, and with little leisure for religious festivals. December and January, however, brought the winter holidays of the farmer in the respite from toil before the labours of the spring sowing commenced. In December took place the Saturnalia, the forerunner of our Christmas celebrations, when friends exchanged presents and master and man joined in a common merry-making. The earlier half of January was marked by rustic festivals in the country, and in the city's calendar by the feast-day of a goddess of birth. February, as we have seen, was mainly given over to expiatory ritual and the worship of the dead.[1]

An Eighteenth-Century Character

By Rowlands Coldicott, M.C., B.Litt.

THE works of Dr. John Wolcot, once better known as "Peter Pindar," are almost forgotten, and the life of the man who wrote them is known only to a very fews But anyone who wishes to wander among the by-way of late eighteenth-century literature will find in the study of impudent Peter an excellent point of departure. Before he has gone far—such is the extraordinary endurance of the past—the present will begin to seem brittle and unreal, and actuality, leaving our much-trumpeted heroes of to-day, will set marching again those more solid people who fiddled and talked and rode and played in the days of George the Third, when modern life in England first began.

Our inquiry may well start with the publication of his first quarto pamphlet in verse. Examine it as it reappears on the next page, for it is something of a curiosity. So far as I know, no copy except mine exists, though perhaps someone will now jump up and refute me. The original issue of these verses "printed for the author" must have been very small. The label that bears the Latin quotation has been pasted over what was apparently in the first instance a misprint. Wolcot was a scholar, and could not tolerate mistakes. "It's poetry that soothes both gods above and spirits below," quotes Wolcot, and he proceeds to give men of the world between, not poetry, but comic verse. As an isolated phenomenon "The Epistle to the Reviewers" would not be remarkable, though it is the first set of verses that Wolcot wrote in what afterwards became his characteristic style; but as a solitary singing shell preluding a long bombardment it is of importance in the history of comic verse. In the third stanza Wolcot promises the public a succession of "Sonnets, Odes, and Legendary Tales" in terms that imply that his pockets were already full of them. Strangely enough, nothing happened for about four years, when a pamphlet appeared in London entitled "Lyric Odes to the Royal Academicians for MDCCLXXXII by Peter Pindar Esq^{re}, A Distant Relation of the Poet of Thebes, and Laureate to the Academy." From that year till 1812, when a collected edition of his works was published in five volumes—all in verse and mostly comic—Pindar's "distant relation" never ceased publishing, and even then outgrew his own collected edition and went on and on, till finally at his death, in 1818, he left a chestful of unpublished manuscripts, many of which are scattered about the world in private collections, and have wandered even to New Zealand.

There must have been something remarkable about a man who could make the public listen for so long. Though he enjoyed writing, he published in order to make money and have a good time. He was no hypocrite, and made no bones about it:

> "Ladies, I keep a rhyme-shop; mine's a *trade*;
> I sell to old and young, to man and maid:
> All customers must be obliged; and no man
> Wishes more universally to please.
> I'd really crawl upon my hands and knees
> T'oblige; particularly, lovely Woman."

Towards the end of his life he said to his friend Taylor: "I was poor, and hunted in vain for Fortune in Europe, Africa, and the West Indies, but at last found her in a shop in Paternoster Row, laughing over my works and advising the booksellers to buy the copyright."

Wolcot made it pretty clear, too, in "The Epistle to the Reviewers," that he was out after commercial success. And yet, knowing the man, it is perfectly certain to me that what he loved far more was the free exercise of his undoubted powers in the presence of as

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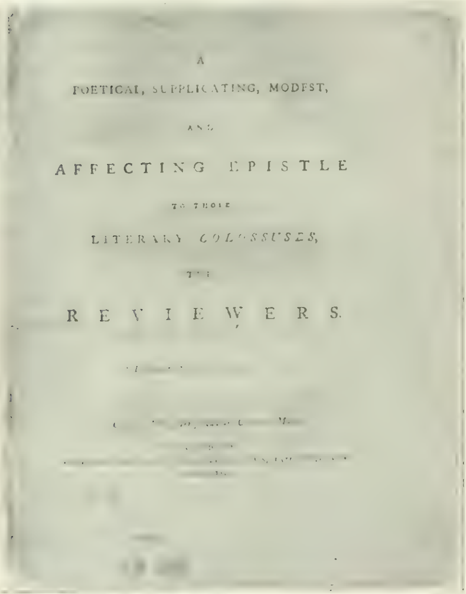
[1] A short but very good account of the calendar and of the development of Roman religion will be found in Mr. Bailey's recent edition of the *Third Book of the Fasti of Ovid.* A longer account is given in *The Roman Festivals of the Period of the Republic*, by the late W. Warde Fowler, the wisest and greatest Roman scholar of our time. His knowledge, which was wide and accurate, was informed by a rare insight and a real humanism. We shall not look upon his like again.

The three best books in English upon early Roman religion are Warde Fowler, *The Religious Experience of the Roman People* (Macmillan); Bailey, *The Religion of Ancient Rome* (Constable); and Carter, *The Religion of Numa* (Macmillan).

[illegible] Ready as he was at the outset for any amount of success, he must have been surprised at the astonishing way his luck held and his reputation spread. It has been said—and there is truth in the remark—that, search where one will among the annals of the last years of the eighteenth century, one is certain sooner or later to run across the pseudonym "Peter Pindar." When Richard Twining, a quiet country gentleman, writes to Dr. Burney and mentions that he is reading Pindar, his sense of gravity allows him to add within a bracket "not Peter." When Miss Burney, in her official capacity at Court, came for the first time into the presence of the King, her recollection of the wicked verses of Peter Pindar added to her confusion. There is a story that the Duke of Kent, travelling at that period in America, entered a cottage, and, seeing a girl with a book in her hand, inquired the extent of her reading. The girl replied, "Sir, the Bible and Peter Pindar!" That is too good a story not to be a story, but the evidence of his immense vogue over a long stretch of time remains. Burns says seriously in one of his letters that he will never be able to write as well as Peter Pindar. Byron of course read him, and took something more than a hint from him for his *Beppo*, the immediate precursor of *Don Juan*. Blake knew his works, and more than once refers to him. Porson the scholar wrote an epigram on him. His works were imitated widely and pirated. His style of verse tale was continued under the title of *Peter Pindarics* by James and Horace Smith, the famous authors of *Rejected Addresses*, in a volume entitled *Gaieties and Gravities*. In most scholarly works on the literature of the time—say 1782 to 1812—contemporary allusions are generally reinforced by footnotes containing extracts from Wolcot's pamphlets. But no one tells us much about the man.


A

POETICAL, SUPPLICATING, MODEST,

AND

AFFECTING EPISTLE

TO THOSE

LITERARY *COLOSSUSES*,

THE

REVIEWERS.

TITLE PAGE OF WOLCOT'S FIRST SATIRICAL PAMPHLET.

If, as Pope said, the proper study of mankind is man, and not, as so many camp-followers of literature believe, the close hunting of tendencies and allusions, then the study of Wolcot himself is more to the point than close reading of his works. A more truthful answer is that the better the artist the more his works suffice, until he "all expresses" himself in them. Henry James develops this view in "The Death of the Lion." But Wolcot—to speak truth—was only occasionally a good artist: it is the history of the man himself, including his writings, that makes him so interesting a study. Few of his verses are of permanent worth, but almost all are very much more alive and provocative than nine-tenths of the lesser verse of his time. He attempts so much, so nearly "comes off" in so many directions, is so versatile and ambitious and voluminous that his readers are certain before long to want to know something more about this man with the writing itch and such a fund of energy. What was he like? How came he to write verse? A very full answer is forthcoming.

All early mentions of him agree that he was a heavy, unwieldy, clumsy boy, quick at repartee and fond of sarcastic jokes. The son of a country doctor who lived at Dodbrooke, in Devonshire, he was given an unusually good education, and at the age of seventeen went for a year to France. On his return he fell into that state of unrest and discontent often engendered in young people who have been "well educated" and then left in the lurch. By this time a benevolent uncle had taken him under his protection and set him to a seven years' apprenticeship in the family profession. Wolcot, who had commenced writing verse when at school, hated the work of an "apothecary," and divided his time between music, poetry, painting—and the young ladies of Fowey. The first published verses of his that can be traced appeared in 1756 in an obscure periodical called *Martin's Magazine*. They were addressed to a lady of great beauty and charm, a Miss Betsy Cranch. He proposed to her, and she accepted him—if he would wait his turn; she was four deep already! Next he transferred his affections to a Miss Chubb, and then to a Miss Coryton. But although he wooed with fury, and always enclosed verses in his letters, none of the ladies of Fowey would have him.

At length, at the close of the year 1762, Wolcot was sent to London to gain some experience of hospital practice. His stay there coincides with the rapid issue of the satires of Churchill. The resemblance between the two satirists is superficial, but both were vigorous and unscrupulous. Gifford, not Wolcot, was Churchill's descendant. Churchill wrote serious satire; Wolcot was always the jester.

Shortly after he arrived in town he stayed with a Mr. Giddy, who thus refers to him in a letter to a friend in Cornwall:

"Mr. John Wolcot, who now lodges with me, has very quick mental parts; but the component parts of his body are remarkably lazy and slow, except his fingers, which, applied to the fiddle or flute, move very nimbly. Entre-nous I am afraid he is too much acquainted with Shaftsbury and Voltair's notions."

He spent two years in London, and seems to have paid a visit to France again. So much is known of Wolcot's life that the gaps in our knowledge are very tantalising. For one gets an uneasy suspicion that there is much that has never been told. It is difficult to say whether he was a rascal or merely a bohemian. Many years later, when Miss Elizabeth Fry came to London, Wolcot was asked to "take her about," as the saying is. Yet he is represented as being an utter scoundrel, so disreputable that no decent lady would care to be in his society. Giffard's *Epistle to Peter Pindar* is the most ferocious attack ever made by one writer on another in the history of English verse. It goes so far that one's sympathy cleaves to Peter. Controversy at that time was waged in a style that makes milk and water of our modern feuds. Byron could not quarrel like Giffard: he used to forget himself into writing poetry. A comparison of *The Vision of Judgment* with *An Epistle of Peter Pindar*—both productions engendered by personal dislike—will reveal, as criticism never can, the untraversable space between mediocrity and genius.

In 1764 Wolcot returned to Fowey, and apparently began to practise as a doctor. The first thing he did was to write a passionate love letter to Miss Sukey Nankivell—who refused him. Here he is describing the opening of her reply:

"DEAR MISS NANKIVELL,

I have just received yours which remains yet unopened—now guess my sensations, all the blood up in my face, my ears tingling, my heart drumming against my ribs, and my spirits in an uproar! What a thin partition between me and despair, or supreme felicity. Fortune has hitherto turned her back on me, but let her now be kind and I will fairly forgive her all her former injurious treatment—A confounded jilt! She has murdered me!—To be plain I have opened your letter, am acquainted with its contents, and find my hopes blasted. . . ."

At this moment there came to Wolcot what appeared to be the opportunity of his life. Sir William Trelawney, with whom he had lately somehow become acquainted, suddenly received the governorship of Jamaica—a rich appointment. Wolcot, already sick of doctoring people at Fowey, immediately approached him, and asked to be taken out as physician to his household. Trelawney, seeing in Wolcot a lively and accomplished fellow of many parts, agreed to take him, provided he was properly qualified as a physician. Wolcot, who had no scruples and much push, managed to obtain immediately the degree of Doctor of Medicine from Aberdeen University, after a formal examination at Plymouth by a Dr. Huxam. On September 2 he writes to his friend Mr. Giddy:

"My friend Thomas has perhaps by this time been informed of my intended peregrination to a place characterised for being as hot as hell and as wicked as the devil. . . . The intent of my western expedition is undoubtedly to get money, for which beautiful acquisition I left friends, sweethearts and old England! . . ."

At the end of the year he writes from London, where he is going to be presented at Court. It is a very long letter full of interest:

"DEAR BENJY,

I am at length arrived in the great city, to prepare for the new farce in which I am shortly to make my appearance; my wigs, my hats, my swords, my canes, my laced cloathes, and last of all,—my chariot are all bespoke!"

He goes on to say that he expects to place himself "by the labour of a few years beyond the caprice of a mob." Afterwards he describes himself drest in white and gold, going in a sedan-chair to St. James's.

There are several letters of his about this time, written so vividly that they bring to us every detail of how he spent many hours of that gay year, waiting for his patron to set forth. At length he departs, and the next letter is from Teneriffe—a letter full of the beauties of Spanish ladies and the exceeding nastiness and number of the fleas there, which he never forgot, and to whom afterwards he wrote an ode. That his verses did not exaggerate the pest, present inhabitants of the town can testify.

Trelawney and his suite and his physician arrived at Jamaica in October 1768. At first all went well with Wolcot. "My time," he wrote, "passes away with the utmost cheerfulness." In fact he had nothing to do. Trelawney, on the other hand, found himself beset with difficulties. No one about him thought of anything but the getting of good "jobs," and a weak [illegible]—and left the island in a state of violent disaffection. Amongst job-seekers Wolcot was *facile princeps*. At first he tried to get the appointment of "Governor of the Mosquito Territory." This scheme failed through the retirement at home of Shelburne, to whom Trelawney owed his present position. At last Trelawney told Wolcot that he could do nothing for him—unless he were in Holy Orders, in which event he could give him the living of St. Ann's, as the rector was very ill and could not live long. This with various fees could be made at that time to yield about two thousand pounds a year. As for the duties, to all intents and purposes they could be ignored. The clergy of Jamaica were, to put it in round terms, a pretty hot lot. Long, who was at this time Speaker of the Assembly, says that some were better qualified to be retailers of salt fish or boatswains or privateers than ministers of the gospel. To such a degree greed was in the ascendant that rectors actually formed a trade-union, and refused to marry or baptise except at enhanced prices. As late as 1800 some would refuse to open a prayer-book out of church for less than five pounds, six and eightpence.

This "beautiful" community (Peter was fond of using the adjective in this ironic way) Wolcot now joined. It necessitated a visit to England—that was all. On Saturday and Sunday, June 24th and 25th, 1769, the kinsman of the poet of Thebes was ordained first deacon, then priest, by Richard Terrick, Bishop of London. Horace Walpole said that Terrick's only episcopal qualifications were "a sonorous delivery and an assiduity of backstairs address."

Wolcot returned to Jamaica at the end of March 1770, about the same time as Chatterton, harbinger of the new spirit in poetry, came up to London. He found the expiring rector had unexpectedly recovered. Trelawney, who must have seen the ironic humour of the situation, kindly advised for his friend, physician and fiddler a new office, that of "Physician-General to all the Horse and Foot Militia raised or to be raised within this island." A few months later the small living of Vere fell vacant, and Wolcot became rector. No one took him seriously. "This," said a gentleman at a dinner-party, "is Dr. Wolcot, the unworthy incumbrance of this parish." After a few weeks the "incumbrance" had dropped all pretence of holding services, and was spending his Sundays shooting wood-pigeons.

The curtain now comes down with the rush of a storm upon Wolcot's Jamaican adventure. That fortune which was to have put him "beyond the caprice of a mob" seemed as far off as ever when in 1773 he obtained a year's leave of absence from his rectory, never to return. The reign of the Trelawneys was over. Malaria had ended the lives of the Governor and his daughter Ann. Lady Trelawney alone remained. It is said that Wolcot, as a last desperate throw, endeavoured to marry her—he certainly had had "designs" upon her daughter, whom he addressed as "The Nymph of Tauris." But even this failed, and the last months of 1773 see the Rev. Dr. Wolcot back in the West Country, setting about to get his living as a physician in Truro.

(*To be continued.*)

Reviews of Books

A New System of Scientific Procedure. By G. SPILLER. (Watts & Co., 10s. 6*d*.)

Textbooks on how to do this, that, and the next thing seem to be produced in great numbers nowadays. One of the latest is a long one (200,000 words) by a Mr. Spiller, and is highly instructive on the subject of pursuing original investigation. Books of this kind are a very modern product and, although greatly pooh-poohed in this country, are in vogue in the United States, where people are less cynical and sophisticated than here, less contemptuous also of the possibilities of youth. Readers of R. L. Stevenson's *New Arabian Nights* will remember that when the Reverend Mr. Simon Rolles had stolen the Rajah's diamond he found great difficulty in disposing of it because he could not find a textbook to give him the necessary information. It was true he was referred to a series of novels in which the ways of crime, including the disposal of stolen property, were dealt with authoritatively, but he could not help reflecting when he had read them all how annoying it was that the information he desired should be "scattered amongst romantic story-telling instead of being set forth soberly after the manner of a manual!"

But that was a couple of generations ago. Nowadays nearly every conceivable subject is set forth soberly after the manner of manuals. From them we learn how to double our incomes, to live to a hundred, to write short stories, or merely to assert ourselves or gain charm of manner. Some day, doubtless, a little series of books, green with yellow spots in colour, will appear in opposition to those of Mr. Pelman, teaching us how we may forget or how we may reduce our incomes, for these are about the only subjects one readily recalls on which a "How-to" textbook has yet to be written.

To return to Mr. Spiller. In his book he attempts to ascertain, develop and systematise the general methods employed in modern research work at its best so that all who are thinking of undertaking such work may be helped. The author regards it as an attempt at a modern statement of Bacon's position in his *Novum Organum*. He has asked himself how best may the human mind be made most effective for the discovery of scientific truth, and from a study of the work and methods of great men of science, the great pioneers, he has tried to give an answer. The author has set about his task with great energy and considerable skill, and has evidently read widely. He has the gift of lengthened quotation. Anyone interested in either the theory or the practice of the scientific method will find this fascinating book of great interest and utility.

But can a man learn from a textbook anything that will help him to carry out original investigation? Many people affirm that such a thing cannot be taught, cannot be learned even by his working with a first-class investigator, much less from a book written by a man who has probably not done a stroke of experimental work in his life. But this is an old-fashioned view put forward largely by investigators who too optimistically assume that the qualities they themselves possess are native and special, while a truer view of the matter is that they learned them from their teachers much in the same way as they learned other things. Talent, whatever that word involves, an investigator must have, but definite instruction in research is necessary also. If original investigations were carried out exclusively by men of the calibre of Darwin, Kelvin, or Faraday one would argue on these lines with some diffidence, but of course this is no longer true. In olden days research was the hobby—pleasant, interesting, but entirely unremunerative—of a few. It could be pursued only by those who had private means or who earned a livelihood by other work. They were naturally men of great ability, and there was neither scope nor talent for those who possessed but ordinary ability. Nowadays things are vastly different. The field of science has extended enormously. Research is the order of the day. At some universities, indeed, it is compulsory in certain subjects for a bachelor's degree. There is work not only for the genius, but also for the man with five talents and for the man with one talent. For the last this book by Mr. Spiller should be of real service. It is by no means perfect, for such a book should be written by a small committee of experts rather than by one man. But it points the way, and it certainly offers a helping hand. A. S. R.

The Analysis of Mind. By BERTRAND RUSSELL, F.R.S. (Allen & Unwin, 16s. net.)

To some of us, one of the most hopeful signs of the present age is the steady development of a New Psychology —a new attitude to life, that is to say, and interpretation of Man; which is not the system of any individual, but a synthesis of the results of many workers in very different fields. It is too soon yet to attempt a systematic description of the structure; but we can begin to discern the outline of the foundations, and to catch a vision of the happy new world that may be built upon them.

Very shortly, and in popular language, we may say that the principles emerging are these: that man is, fundamentally, a creature of instinct and intuition, not a "logical being"; his reasoning powers are his best tools (but only tools) for achieving his aim of harmonious self-expression; mind and body are but different aspects of a "neutral stuff"; his desires (objectively, his restlessness until satisfaction) can be turned to worthy ends, or unworthy ends, but cannot be destroyed. The chief contributions to this work have come from the study of comparative religion and anthropology; from examination of the problems of education (Professor Stanley Hall in America, and Dr. Montessori in Italy, to take two very different aspects); and, above all, from the vast new field of exploration opened up by Professor Freud's epoch-making work on nervous disorders and the interpretation of dreams. Mr. H. G. Wells's heroic attempt at a History of the World is a symptom of the same spirit.

In *The Analysis of Mind*, by Mr. Bertrand Russell, we have a welcome contribution from the standpoint of the mathematical philosopher. Here we find an admirably lucid statement of the problems of philosophical psychology (if we may use such a term to designate Mr. Russell's system of psychology; which is arrived at rather by logical analysis, than by the empirical, scientific methods of, say, Freud), and an attempted reconciliation of the conflicting views now current; with the further aim of bringing psychology into harmonious relations with the science of physics. Mr. Russell is, of course, much too acute a reasoner to accept all the doctrines advanced by too-enthusiastic investigators of this promised land—many of whom, indeed, have weak heads, and suffer from a sort of spiritual intoxication. It is just for this reason that the douche of his clear, cool logic is of such value. He is particularly good in his criticism of early Freudian doctrines, and the mistake of attempting to reduce all desire to a physical sex-hunger. Of the later developments of psycho-analytic theory, on very much broader lines, he is evidently unaware (indeed, they have not yet found considered and coherent expression in print) of the abandonment, that is, by many exponents, except in special cases, of the "censorship" theory; of the subdivision of the unconscious—which would better be called the "other-conscious"—into sub-conscious (instinct) and super-conscious (intuition); of the discovery that the unconscious often contains motives as much higher than the conscious ones as the Freudians discovered lower; all this he does not discuss. But his judgments on the earlier theories are so acute and unprejudiced that we may expect most illuminating and helpful criticism, when he has had time to study the new development. As it is, many of his conclusions are in complete agreement with the work done in other fields. This, for instance, which deals with the satisfaction of conscious desires which do not correspond with the more fundamental desires in the unconscious: "A secondary desire, derived from a false judgment as to a primary desire, has its own power of influencing action, and is therefore a real desire according to our definition. But it has not the same power as a primary desire of bringing thorough satisfaction when it is realised; so long as the primary desire remains unsatisfied, restlessness continues in spite of the secondary desire's success. Hence arises a belief in the vanity of human wishes: the vain wishes are those that are secondary, but mistaken beliefs prevent us from realising that they are secondary." Again, here is confirmation for those who say that in order to learn, children must be interested; and that flogging, or its modified equivalent, is no substitute (a thing which sounds obvious, but is constantly neglected in our schools—teachers being [illegible] the children and then resorting to [illegible]. Learning is only possible when instinct supplies the driving force. The animals in cages, which gradually learn to get out, perform random movements at first, which are purely instinctive. But for these random movements they would never acquire the experience which afterwards enables them to produce the right movement." And this, as to what can, and cannot, be inferred from an examination test. "There is obviously an observable fact called 'knowing' such-and-such a thing: examinations are experiments for discovering such facts. But all that is observed or discovered is a certain set of habits in the use of words. The thoughts (if any) in the mind of the examinee are of no interest to the examiner; nor has the examiner any reason to suppose even the most successful examinee capable of even the smallest amount of thought." In its context this quotation is less startling than it sounds isolated. Mr. Russell has been showing that all our knowledge apart from instinct (and one would like to add intuition) may be adequately described as "behaviour-habits"; and it is these, and these alone, which we test in an examination.

But it is difficult for the philosopher not to exalt the reason into the master of man; instead of the tool, or, at the best, the collaborator, of his instinctual and intuitive nature. Even Mr. Russell writes: "Psycho-analysis, as everyone knows, is primarily a method of understanding hysteria and certain forms of insanity; but it has been found that there is much in the lives of ordinary men and women which bears a humiliating resemblance to the delusions of the insane." The thorough-going Neo-humanist would rather write: "For many hundreds of years man was oppressed by the humiliating belief that members of his species were liable to behave in a totally irrational manner, destructive of the self and of the race. It has now been discovered that in most such cases (and it probably will be discovered that in all such cases) there is present the essentially sane instinct of self-development; the apparent madness is due to a natural reaction to an impossible environment, or to the logical principle in man choosing a mistaken means of achieving a perfectly reasonable end—an accident that is liable to happen to any of us." Thus mad people cease to be a perpetual question-mark (like the figure of Death in Hans Holbein's pictures) to the sanity of mankind, and become, like other sick people, a stimulating challenge to us to develop our faculties and discover the proper way of curing them.

D. N. BARBOUR.

Books Received

(Books mentioned in this column may or may not be reviewed elsewhere in this number, or in a later number.)

FICTION

The Master of Man: The Story of a Sin. By HALL CAINE. (William Heinemann, 6s.)

Karma and Other Stories and Essays. By LAFCADIO HEARN. (George Harrap & Co., Ltd., 5s.)

HISTORY AND ECONOMICS

Spain since 1815. By the MARQUIS DE LEMA. (Cambridge University Press, 4s. 6*d*.)

A Digest of British Economic History. By F. H. M. RALPH, M.A., and W. J. N. GRIFFITH, B.A. (John Murray, 5s.)

A concise and stimulatingly-written introduction to British Economic History. Starting with the Stone Ages, the authors bring us down to the complicated economic and social conditions of the present day. We note as particularly interesting the chapter on the mediæval guilds, that on the economic problems and theories of the early nineteenth century, in which the views of Adam Smith, Malthus, and Ricardo are clearly analysed, and the concluding chapter on the effect of the development of Trade Unions and the various tendencies of socialism. Not the least amongst the virtues of this survey is its politically unbiassed attitude to its subject. We confidently recommend it not only to schoolmasters, but to adults, whom the war has stimulated to a study of economics.

Prehistory. By M. C. BURKITT. (Cambridge University Press, 35s.)

LITERARY CRITICISM

The Tale of Terror. A Study of the Gothic Romance. By EDITH BIRKHEAD, M.A. (Constable & Co., Ltd., 15s.)

Bibliography of English Language and Literature, 1920. Compiled by Members of the Modern Humanities Research Association. (Bowes & Bowes, Cambridge, 3s.)

A scientifically-compiled catalogue of books published throughout Europe and the British Empire on the English Language and Literature. The main headings in the Language section are *Vocabulary, History of Language and Grammar, Phonetics, Metre and Style*; the main headings in the Literature section are *Old English, Middle English, Old and Middle English: Subsidiary, Modern English.* As an example of the careful methods employed, the *Modern English* sub-section is further subdivided into sections dealing with the work of each century from the sixteenth to the twentieth, under the headings *General* and *Authors*. An extremely good three-shillingsworth for lecturers and students concerned.

MISCELLANEOUS

Fabre: Poet of Science. By DR. C. V. LEGROS.

A second impression of a book first published in 1913, which gives an account of the life of one whom Darwin described as "an inimitable observer" of insects and small animals.

From a Modern University. Some Aims and Aspirations of Science. By PROF. ARTHUR SMITHELLS, F.R.S. (Oxford University Press, 12*s.* 6*d.*)

Occasional addresses given before 1914 on the relation of the modern Universities to the world, on the relation of science to life, on classical and scientific curricula in schools, and allied subjects. Well-informed and interesting. Like Prof. Soddy's book, *Science and Life,* on similar subjects, it suffers through being a collection of addresses and not a continuous book. A discussion by these authors of the subjects of this book embracing the lessons taught by the war, particularly with regard to the relation between both the modern and the older Universities and public life, would be a valuable one. A book on these lines is badly wanted.

A Short History of Newnham College, Cambridge. By ALICE GARDNER, M.A. (Bowes & Bowes, 7*s.* 6*d.*)

A singularly interesting account, by a former Fellow and Lecturer of Newnham, of the rise and growth of her old college. In the autumn of 1871 a house was found in Regent Street, Cambridge, and Miss Clough (sister of the poet) and five students began their common life in a new stage in the movement for the higher education of women. They had few comforts, no garden, no games, not a little opposition, and many battles to fight. To-day Newnham is large and flourishing, with four halls of residence, well staffed, well equipped, and with a tradition of which every woman who has passed through her gates is proud. The book is dedicated to two who did much for Newnham in the early days—Miss A. J. Clough and Henry Sidgwick. It is not in the least controversial in tone, but the case for the admission of Cambridge women to higher degrees is well put.

A Philosopher with Nature. By BENJAMIN KIDD. (Methuen & Co., Ltd., 6*s.*)

Some Birds of the Countryside. The Art of Nature. By H. J. MASSINGHAM. (T. Fisher Unwin, Ltd.)

Our Title and Its Import. The Presidential Address for 1920–21, delivered at Bedford College by PROF. OTTO JESPERSEN. (Publications of The Modern Humanities Research Association, No. 4. Bowes & Bowes, Cambridge, 1*s.*)

PHILOSOPHY

The Reign of Relativity. By VISCOUNT HALDANE. (John Murray, 21*s.*)

A Treatise on Probability. By JOHN MAYNARD KEYNES. (Macmillan and Co., Ltd., 18*s.*)

PSYCHOLOGY

The Analysis of Mind. By BERTRAND RUSSELL, F.R.S. (G. Allen & Unwin, 16*s.*)

The Beloved Ego. By DR. W. STEKEL. (Kegan Paul, 6*s.* 6*d.*)

The International Psycho-Analytical Library. Edited by ERNEST JONES. (The International Psycho-Analytical Press and George Allen & Unwin.)

No. 1. *Addresses on Psycho-Analysis.* By DR. J. J. PUTNAM. Price 17*s.* 6*d.*

No. 2. *Psycho-Analysis and the War Neurosis.* Price 7*s.* 6*d.*

Dr. Putnam was Emeritus Professor of Neurology at Harvard, and one of the earliest, and latterly the most distinguished, exponents of psycho-analysis in the United States. This book contains twenty-two papers written between 1909, when the author became interested in the movement, and 1918, when he died. They are written in a charming style, revealing the outlook of a large-minded and particularly sane American. Most are of an expository nature. They show (as Dr. Freud points out in a short introduction) how the writer accepted the essence of psycho-analysis, recognised its capacity for throwing a clear light upon the origin of human imperfections, and how he was struck by the prospect of contributing towards the improvement of humanity along analytical lines; how he then became convinced by his own activities as a physician as to the truth of most of the psycho-analytical conclusions and postulates, and then in his turn bore witness to the fact that the physician who makes use of analysis understands far more about the suffering of his patients and can do more for them than was possible with the earlier methods of treatment; and, finally, how he began to extend beyond the limits of analysis, demanding that as a science it should be linked on to a particular philosophical system, and that its practice should be openly associated with a particular set of ethical doctrines The book may be recommended to those who have some knowledge of psycho-analysis as heartily as one would recommend a good volume of sermons.

The second volume contains an article on war shock and Freud's theory of the neuroses, by Dr. Ernest Jones, and three papers on similar subjects read at a Congress at Budapest in 1918. A technical work for advanced students.

SCIENCE

The Scale of the Universe. By HARLOW SHAPLEY, Mount Wilson Observatory and Carnegie Institution of Washington, and HEBER D. CURTIS, Director Allegheny University. (Bulletin of the National Research Council of the National Academy of Sciences, Washington, D.C., 60 cents.)

A Manual of Seismology. By CHARLES DAVISON, Sc.D. Cambridge Geological Series. (Cambridge University Press, 21*s.*)

A [illegible] be heartily recommended to students of Earthquake Phenomena.

Electrons and Ether Waves. By SIR WILLIAM BRAGG, F.R.S. (Oxford University Press, 1*s.*)

See first article in this number.

The Ether Stream. An Explanation of the Cause of Gravitation. By J. S. MILLAR. (Watts & Co., 2*s.* 6*d.*)

Unscientific and untrustworthy.

Ameboid Movement. By PROF. ASA A. SCHOEFFER. (Princeton University Press and Oxford University Press, 10*s.* 6*d.*)

A monograph by the Professor of Zoology in the University of Tennessee.

Insects and Human Welfare. By CHARLES THOMAS BRUES. (Cambridge: Harvard University Press. London: Oxford University Press. 10*s.* 6*d.*)

This is an account, by an Assistant Professor of Economic Entomology at Harvard, of the more important relations of insects to the health of man, to agriculture, and to forestry. The chapters deal with insects and the public health, insects and the food supply, forest insects, household insects, and the outlook for the future. The past few decades have witnessed great changes whereby the field of the entomologist has been greatly extended, and here in a form neither too technical nor too "popular" is an account of the progress made. The book is well illustrated and may be heartily recommended to readers.

The Control of Life. By PROF. J. ARTHUR THOMSON, M.A. LL.D. (Andrew Melrose, 7*s.* 6*d.*)

The Electric Furnace. By J. N. PRING, M.B.E., D.Sc. (Longmans, Green & Co., 32*s.*)

Thermionic Tubes in Radio Telegraphy and Telephony. By JOHN SCOTT TAGGART. (The Wireless Press, 25*s.*

Correspondence

To the Editor of DISCOVERY

DEAR SIR,

Have you not been less than fair to the reputation of Paul Gauguin (1848–1903) in your article entitled "Revolutionary Movements in Modern Painting" in the current number of DISCOVERY? Gauguin gave up his occupation and means of subsistence late in life, in order to devote himself exclusively to his art. Finding that he could not free himself from the trammels of artistic and other conventions in France, he forsook all, went alone to Tahiti, and subsequently to the less frequented Isles Marquises, where he died alone. By the studied simplicity of his work and its avoidance of all unnecessary detail and definition, he tried to point the way to a greater freedom of expression and to make painting a universal language, which no one with an artist's vision need be afraid to use for lack of training. He would have endorsed a saying attributed to Dégas that it is only the bad painters who are not artists. There can be no doubt that Gauguin's fame continues to increase as his work and its meaning become more widely known.

No one accustomed to look at such things could fail to be struck by the beauty of design and decorative qualities of this master's work, as seen in black-and-white in the well-illustrated French monograph. To come unexpectedly upon the original of one of these illustrations, as the present writer did recently in an art dealer's shop window in Paris, is an astounding revelation of how such beauty of design can be enhanced by brilliancy of light and colour. A superficial observer of this picture might easily have supposed that the whole effect was produced by these latter qualities, though the subject was an early portrait group of a brother painter and his family in his studio, and not one of Gauguin's later gorgeous tropical scenes.

Yours faithfully,
HENRY L. P. HULBERT.

THE COTTAGE, BRIXWORTH,
NORTHAMPTON.
August 10, 1921.

To the Editor of DISCOVERY

DEAR SIR,

After reading Dr. Russell's very interesting article on Isotopes, I am emboldened to ask him a question which has been in my mind to put to him since Mr. Darwin's article in February 1920. Mr. Darwin gave a list of the chemical elements based on Moseley's atomic numbers from 1 to 92, and evidently he and Mr. Russell are of opinion that, once we have found the few undiscovered elements between those numbers, science will be more or less satisfied.

Now, I have read in my very discursive readings that there are two elements which have been actually discovered external to the Earth, namely, Coronium in the sun, and Nebulium in the stars, but somehow it seems to me that neither of these elements will fit in with those undiscovered elements in Moseley's list. Will you be kind enough to ask either of these gentlemen if it is a fact that these two elements do exist, and that being so, what do they imagine their atomic numbers to be?

Yours faithfully,
GEO. C. WILLIAMS.

99 MERCER'S ROAD, N.19.
July 31, 1921.

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Editorial Notes

THE speech of the President of the British Association at Edinburgh this year was quieter in tone than the usual presidential address. There was nothing about our coal or our supplies of wheat getting rapidly exhausted, or about the origin of life, or of continuity of life after death. This was rather hard on the daily press. The press likes the president to make sensational statements, so that when appropriately written up they may keep interest going for a few days at least. Yet the speech was a good one. Sir Edward Thorpe dealt with three main topics: the work of the department of Science and Industrial Research, the recent work on "isotopes" and the structure of the atom, and the relation of organised science to the prosecution of war.

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Of the second of these topics little need be said here, for two or three articles upon it have already appeared in our columns, but a word or two on the manner in which this subject was reported in some of the London dailies may not be out of place. It was not well done. Some reporters treated it as entirely new work, carried out perhaps in secret during the last fortnight of August and whispered into the president's ear as he wrote his speech, and in many papers the description of the work even by *Our Special Correspondent* was not informed. Now the nation's attitude towards science and scientific research is of great importance with regard to its position and continued existence, and the daily press, if it chose to take a little more trouble, could do yeoman service in the creation of the right attitude. Any kind of accuracy on scientific matters will not do, but the press does not realise this. If a contributor were to declare that Consols are to be redeemed at par a week next Friday, that by insisting on laying ten to one on every horse that ran in a race a backer would speedily make a fortune, his editor would speedily tell him to desist, yet mistakes on scientific matters as glaring as these occur in papers accurate enough on finance and sport. And the advancement of science is of greater importance than finance or horse-racing.

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With regard to the third topic of the president's speech, the relation of organised science to war, the speaker opened up many interesting problems. One of these, which will keep many people busily arguing, is, "Was the war due in some measure at least to the possession by the warring nations of the deadly weapons which the discoveries of science have produced? In other words, is not science a curse? Or was the war due to the fact that progress along moral and ethical lines had failed to keep pace with man's increasing mastery over nature, to the fact not of man's inheritance, but of his failure to be worthy of it?"

* * * * *

An interesting problem in conduct also arises. Should a research worker, whose views of war are those of Sherman, consent to undertake scientific work which he feels sure will be utilised in what cynics and others call the next war? Should a chemist, for example, consent to experiment with new forms of poison gas? It is often argued that very well he might, for, if war be inevitable, poison gas is far less fatal and far less cruel than any other instrument in finishing the "inevitable" war in the shortest possible time. For it has been stated, and it appears to be true, that "amongst the 'mustard gas' casualties in the war the deaths were less than 2 per cent., and, when death did not ensue, complete ultimate recovery generally resulted. Other materials of chemical warfare in use at the Armistice do not kill at all; they produce casualties which, after six weeks in hospital, are discharged practically without permanent hurt." Yet after reviewing the matter Sir Edward Thorpe expressed very plainly his opinion not only of the poison-gas matter, but of the broader problem, the opinion it is hoped of every decent-minded man and woman in the country: "An educated public opinion will refuse to give credit to any body of scientific men who employ their talents in devising means to develop and perpetuate a mode of warfare which is abhorrent to the higher instincts of humanity . . . and will set its face against the continued degradation of science in augmenting the horrors of war."

* * * * *

The meeting of the British Association this year was further interesting because of the wide appeal that it made to many who have not previously been touched by its meetings. It has not been easy in the past for the organisers to know what line they should take—whether to make the meetings popular, that is, attract the public and impress the nation, or confine them to specialists in order that scientific workers, students, schoolmasters, schoolmistresses, and others, who cannot run up to London during the working year every time something is "on" at one of the learned societies, might learn at first-hand what the research folk have been doing in the past year. But, as the Association has now thirteen sections, and as many of these hold concurrent meetings, it was found possible to arrange that both classes of the public were adequately considered. Subjects like those dealt with in Professor Richardson's address on "Problems of Physics," or in Professor Lloyd Morgan's on "Conscious and the Unconscious," and in the presidential addresses to the sections of Chemistry and Botany, were quite clearly of interest to specialists only; but Sir Henry Hadow's lecture on "The Place of Music in a Liberal Education," or Mr. Hichens' on "The Principles by which Wages are Determined," or Dr. Hogarth's on the "Application of Geography," and the presidential addresses to the sections of Geology and Agriculture, were, by the nature of their subjects or treatment, of great general interest.

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A feature this year was the number of joint discussions. A short list of some of these subjects was given in the Editorial Notes last month. It is admittedly a good thing to get specialists in mathematics, physics and engineering, or in zoology, botany, and physiology, or in geology and anthropology, to discuss together some general question which is studied in common. Science is now so detailed (we tremble for those who will study physics, chemistry or psychology fifty years hence) that no one can be "inside" more than one of its branches. If then a problem is on the border-line, a worker in one science must look for help from one in the sister science. This interchange of views on a subject is, therefore, valuable, and not only, it is found, merely in the acquisition of information, but also in enhancing the subject's interest.

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The new science of psychology in which the public interest is so great has now a section of its own, (it was formerly a sub-section of physiology), and some of the most interesting papers of the meeting were read in this section. These varied over a wide field, for the psychologists do not believe in maintaining a narrow front. Dr. W. Brown opened a discussion on the relation of suggestion to psycho-analysis, a relation important from a theoretical point of view no less than from the practical. Freud himself has admitted that the factor of transference, (of which suggestion is a form), is essential in any course of psycho-analysis that is to lead to a cure or amelioration of the patient's condition, and this position was taken as the starting-point of discussion. Dr. C. W. Kimmins described an investigation which he had made into the sense of humour in school children. He has analysed a large number of jokes and funny stories recorded by children of different ages, and found out the elements which produce laughter and amusement at different ages, and the variation in this respect between boys and girls. The greatest changes in these elements he finds are associated with periods of rapid growth. He finds there are certain types of funny stories and humorous incidents that have a universal appeal, and he has worked out a reason for their survival even after a long life. It is hoped that this paper will be printed in an accessible place, not only because of its own interest, but also for the use that may be made of it by those who look after children.

* * * * *

In the Anthropology Section Mr. Miles Burkitt, whose book on *Prehistory* has been recently published by the Cambridge University Press, read a paper on a recent discovery of importance in Upper Palæolithic Cave Art. It is a good many years now since the discovery of the first Palæolithic Cave painting, and archæologists feel fairly sure that these extremely well-drawn engravings and paintings were made for magical purposes to obtain a good catch of game for these early hunters who, it is thought, knew nothing of metal, of agriculture, or of domesticated animals. A frieze of engraved animals (comprising horse, bison, lion, reindeer in many attitudes, bear, rhinoceros and mammoth) has recently been discovered in a cave in the Pyrenees, surmounted by the dominating figure of a masked man, wearing a stag's antler on his head and a tail. Was this merely the usual sorcerer of the cave, asked Mr. Burkitt, or does it represent a primitive but ingenious method of catching stag? Now a certain very early Gallic god was always shown masked as a stag, and a Cretan god of Minoan times also, and the question is now raised as to whether there is any cultural connection between these representations of masking as stags.

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The subjects of discussion were legion—the amount of information imparted very great. And next year they will be at it again! But the British Association is something more than a disseminator of scientific knowledge. It is a witness to the spirit of science, and an earnest advocate of the need for the adoption of that spirit by the commonwealth. It seems quite clear that scientific knowledge is going to transform the world *if* it be acted upon, and *if* men will make themselves worthy of the gifts that this knowledge has already brought and is still to bring them. In the degree that the general public realise this and support the work, to that degree the work goes forward and the public benefits. It is a pity that even now many people regard scientific workers as a curious group of old gentlemen with their heads metaphorically in the clouds. But it is they who remove mountains. The "tame scientists" the clever illustrated weekly calls them, overlooking the fact that it is "tame scientists" who have made it possible for the weekly to appear at all. Scientific work is a service of public utility. The knowledge derived from it can help in every department of life. If the last ton of coal or the last drop of oil has been burned, it can suggest another way of producing energy. If ten homes in a side street are served each day by four milk-carts, three bakers' carts, three grocers' carts and two butchers' carts and a few errand boys on bicycles—well, it can make certain suggestions for improvement there too. Science does not solve all life's difficulties, but it is a mighty and willing helper if we care to co-operate with it.

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An interesting development in modern spoken English is traced by Professor Wyld in his article, "Standards of Correctness in English," the conclusion of which we publish in this number. This is a tendency that has affected our speech, as he shows, since the days of the eighteenth century—a change largely due to the standardisation of spelling in school and dictionary. The fact is that we are accustoming ourselves more and more to pronounce our words according to the way in which we spell them. Such a tendency is particularly noticeable amongst many of our American cousins, who are apt to pause on each separate syllable of a word, according to its spelling. But, perhaps, the alteration in the spoken language is most striking in the English countryside, where you can often hear grandfather speaking in the local dialect, and his ex-soldier grandson using a cosmopolitan speech developed at the village school and in the Army, and largely influenced by the written word.

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Professor Wyld is a well-known authority on the study of the English language. He graduated at Oxford, but he also studied at two German universities, Bonn and Heidelberg, both conspicuous in the world of etymology. He held a Special Inspectorship of the Teaching of Phonetics in the Training Colleges of Scotland, the Baines Professorship in English Language at Liverpool University, and was last year appointed to the Merton Professorship of English at Oxford. Besides contributing to the study of popular dialects, he is well known for his various works on phonetics, a subject of whose claims he has been a strong advocate, especially as a part of the training of teachers. Few modern books or notes on the English language are written without some reference to his two standard works, *The Historical Study of the Mother Tongue*, and *A Short History of English*. His latest book on phonetics[1] *A History of Modern Colloquial English*, has been welcomed as an original treatment of its subject.

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Our first sensations of horror at the disaster to the ZR2 have already been modified by the course of time. The loss of that gallant band of experts who met their death in the catastrophe is a new and grievous part of the price which mankind has paid in its continual struggle to master the powers of nature. We do not wish to appear callous, but we sincerely hope that the sudden end of the ZR2 will not affect the schemes of imperial transport which the new Air Ministry is trying to foster. There can be no doubt that lighter-than-air machines will eventually become the *goods-trains* of the air. Their greater wind-resistance may never allow them to develop the speed of the aeroplane, but we have already seen that they can outdo the latter in weight-lifting capacity and length of cruising range. Their safety should be greatly increased by a more general use of helium gas for inflating the envelope. It is far less inflammable than any other gas so far put to this purpose, but its cost of production is, unfortunately, very high. We hope that a more economical process of producing this gas will be discovered.

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[1] Published by T. Fisher Unwin, 1920, 21*s*.

The City of the Sun-Cult

An Account of the Recent Excavations at Tell-el-Amarna

By T. E. Peet, M.A.

Professor of Egyptology in the University of Liverpool

To the student of Egyptian history Tell-el-Amarna is something more than a mere place-name. It is connected with what is perhaps the most striking event in the life of Ancient Egypt, the so-called heresy of Akhenaton. Any exploration undertaken on this site has a very definite purpose, namely the clearing up of the history of this little-known and supremely interesting episode, and it would be useless to describe the excavations which have been made there without giving the reader some general account of Akhenaton and his religious revolution.

First, however, a word regarding Tell-el-Amarna itself. The name is a solecism, for which the archæologist is to blame. The mounds to which the name is given, and which cover the remains of Akhenaton's city, lie near a modern Arab village called Et-Till, on the east bank of the Nile some 200 miles above (i.e. south of) Cairo. The district in which Et-Till lies is inhabited by a formerly nomadic tribe named the Beni Amran, from whom it takes the name of El-Amarna. Thus the village may for purposes of closer definition be called Till-el-Amarna, that is, Till of the Amarna district. The blunder was made when Wilkinson, as early as 1835, mistook Till for the word *tell*, which means a mound or hill, and put into currency the compound Tell-el-Amarna, which is now too firmly established to be suppressed.

The XVIIIth Dynasty, which began about 1587 B.C.,[1] had witnessed the widest expansion of Egyptian power. The kings of the XIIth Dynasty (2000 to 1788 B.C.) had conquered Nubia, and even on occasion brought back great booty from Syria-Palestine, but they had, so far as we know at present, attempted nothing like a policy of conquest in nearer Asia. In the dark years which followed the fall of this dynasty, Egypt had been herself invaded by Asiatics, the hated Hyksos. After the expulsion of these intruders by the first kings of the XVIIIth Dynasty, she again rose to prosperity, and a period of reprisals against the Asiatics followed almost as a matter of course. There is not space here to describe the details of the wars which ensued; suffice it to say that by the time of Thothmes III (1501 to 1447) the Egyptians had conquered the whole of Palestine and Syria as far north as the Lebanon, and had even struck off to the north-east through the country known to them as Naharin and reached the Euphrates. Under Amenhotep III this empire was maintained, and his son, Amenhotep IV, afterwards called Akhenaton, inherited it unimpaired. There were, however, heavy clouds on the political horizon, for at the very moment of his accession the Hittites, whose empire lay in Central and Eastern Asia Minor, were threatening Syria from the north, while a people called the Khabiri (by some identified with the Hebrews) were drifting across the Jordan into Palestine in ever-increasing numbers.

Amenhotep III died about 1375 B.C., leaving a widow, Queen Ti, and a young son, Amenhotep, to succeed him. The internal situation in Egypt at this moment seems to have been perfectly normal. The court resided at Thebes, the modern Luxor, 450 miles above Cairo, as it had done since the beginning of the XIIth Dynasty, six hundred years before. The state religion consisted mainly in the worship of the god Amon-Ra, who, as the name implies, was a syncretism of the Sun-god Ra, one of the most ancient of deities in Egypt, with Amon, the local god of Thebes. This combination was both old and stable, and had been made in the usual easy Egyptian manner at the time when an obscure Theban family rose to power and conquered the whole of Egypt, conciliating religious prejudices and differences by uniting its own city-god Amon with the old state-god Ra. Side by side with the state worship of Amon-Ra there coexisted that of an almost innumerable pantheon of other deities, some local, some general, all with their priesthoods and adherents.

Such, then, was the state of affairs in 1375 B.C. But an astounding change was at hand. Not later than the sixth year of his reign, possibly as early as the fourth, the young king had moved his court from Thebes to Tell-el-Amarna, suppressed the time-honoured pantheon of Egyptian deities, and established a monotheistic worship of the Sun's Disk, or Aton, as it was called in Egyptian. Workmen were sent throughout the land to chisel out the name of Amon, and often those of the other gods too, in the monumental inscriptions of temple and tomb; the temples of Thebes stood empty, and shorn of their revenues, and all the most skilful men in Egyptian art and craft were assembled in Tell-el-Amarna, building and adorning the vast temple of the Disk. Here the king founded his new city, Akhetaton (*Brightness of the Disk*), in a place "which belonged to no god and to no goddess, to no prince and to no princess," at the same time changing his name from Amenhotep ("*Amon is satisfied*"), to Akhenaton ("*The Disk is pleased*").

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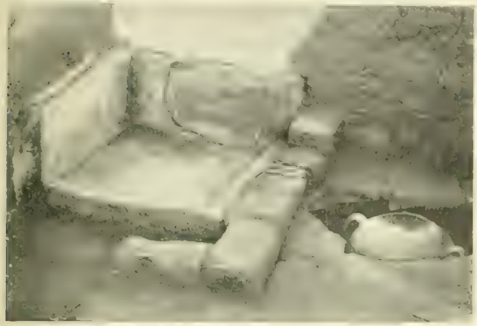
[1] The dates of the Egyptian Dynasties are determined astronomically, the calculation being based on the fact that the Egyptians, though they had a year of 365 days, failed to provide a Leap Year, and so got out of time with the Solar Year and its seasons to the extent of a day in every four years. Thus, if an inscription tells us that in a certain year of a certain king the beginning of the true or Solar Year fell on the 23rd of the third month of the Calendar Year, we can at once fix the date of that year, since we happen to know from ancient writers the dates (recurring every 1,460 years) at which the Egyptian Solar and Calendar Years began on the same day.



BATH MADE OF LIMESTONE SLABS WITH VASE FOR REMOVING THE WATER.

(Reproduced by courtesy of the Egypt Exploration Society.)

It will at once be observed that the new religion has a point of contact with the old, for the new god is, like the old, a Sun-god. To this extent the new creed cannot rightly be called, as it often is, a heresy. But the presentation of the god was entirely altered. He was now represented, not in the old form of a hawk-headed man with the sun's disk on his head, an image born of a very ancient syncretism of Ra with the hawk-deity Horus, but under the form of a disk overhead, from which shoot down earthward numerous rays, terminating in hands offering symbols of life to the worshipper.

A large crop of problems has naturally sprung from the scanty account which has come down to us of this revolution. Here we must do little more than state them, hinting at the conclusions which on our present evidence appear most probable. Thus we are told by the anatomists who have examined Akhenaton's mummy, found not many years ago in the tomb of his mother, Ti, at Thebes, that the king cannot have been more than thirty years of age at death, and was very probably several years younger. As we know him to have reigned at least [1] seventeen years, this gives him a maximum of thirteen years at his accession, and of nineteen years at the moment of the revolution. Can a boy of nineteen have conceived and carried out so huge a scheme, or was there someone else behind it, possibly his mother, Ti? Having regard to the greater precocity of youth in the East, it seems by no means impossible that the king should have been himself responsible both for the conception and for the working out. Ti had probably little to do with it, and there seems some reason for believing that she remained at Thebes. Attempts to trace the origin of the heresy, through Ti and her supposed Asiatic parentage, to Syria are ill-advised, for the discovery a few years back of the mummies of Ti's parents in their untouched tomb at Thebes shows them to have been both of perfectly normal Egyptian type. On the other hand, recent discoveries have shown that the Disk, or Aton, had already a temple at Karnak under Amenhotep III, in which, though he was not as yet represented under the new form, he already bore the new and complicated name, formerly believed to have been given to him by Akhenaton, "Horus-of-the-Horizon, who rejoices in the horizon, in his name of Brilliance which is in the Disk."

An equally difficult question is this: Was the heresy a purely political move, initiated by Akhenaton in order to escape from the ever-increasing power and intrigue of the priesthood of Amon-Ra; or was it in truth a new philosophy with an improved ethical code, which the king felt himself called upon to preach to his people? Probably the truth lies in a combination of these two views. We do know that the priesthood of the Amon-Ra, into whose coffers the booty of almost annual victorious campaigns in Asia was poured, was already a menace to the throne which it eventually overthrew and usurped. On the other hand, no one who has read the wonderful *Hymn to the Disk*, probably composed by the king himself, one of the most remarkable documents in the early literature of the world, can doubt that the words are those of a man inspired by and convinced of the beauty and importance of his mission. Attempts have been made to deny him the credit of having reduced polytheism to monotheism, but there

BOTTLE OF VARIEGATED GLASS IN THE FORM OF A FISH.

(Reproduced by courtesy of the Egypt Exploration Society.)

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[1] The wine jars from the royal stores at Akhetaton were inscribed with the year of the king's reign in which they were laid down. They run in an unbroken series up to year 17.

is not much to be said in their favour. The man who was wise enough to write the *Hymn to the Disk* was probably also wise enough to see that some temporary concessions to popular belief were not only advisable but necessary, and to make them in those directions where they least mattered to the essence of his doctrine. To call him a polytheist because he allowed the word "truth" to be written, as of old, by means of a hieroglyph which was a figure of the Goddess of Truth is mere stupidity.

Such was the man and such was the episode in which he figured. We may now turn to the scene on which it was enacted. Near the village of Et Till the hills which form the beginning of the high desert in Egypt come down to the river edge both to the north and south, thus enclosing a semicircular sandy plain whose diameter is the Nile and whose circumference is the barrier of desert cliff. This was the spot which Akhenaton chose for his new capital. The ruins, covered with a thin layer of sand, lie not half a mile from the river, and are five miles in length by half a mile in breadth. In the face of the cliffs, between two and three miles from the town, lie the rock-hewn tombs of the nobles, some finished and probably never used, others not even finished, for the town was inhabited for no more than about twenty years. Several striking valleys run far eastward into the desert, and in one of these are the royal tombs, two unfinished, and the third in part at least finished, and used for the burial of one or more of the king's numerous daughters, perhaps also for that of Akhenaton himself, though his body was, as we have seen, afterwards removed to Thebes. At various points in the cliffs tablets are cut in the rock marking out the boundaries of Akhetaton, and bearing long and important inscriptions. Three of these tablets are also found in the cliffs on the western side of the Nile, for Akhetaton in theory extended on both sides of the river.

As early as 1824 an English explorer, Wilkinson, visited the tombs of the nobles, and also re-discovered the famous alabaster quarry of Hatnub away in the desert behind them. The town mounds, however, attracted less attention until 1887, when a happy, or unhappy, accident brought them before the notice of the archæological world. A native of Et Till, digging among the ruins for the rich manure-earth known as *sebakh*, found in the ruins of a house a large number of baked clay tablets covered with cuneiform writing. These were taken to Cairo and declared forgeries by the museum experts, and a similar judgment was passed on some specimens sent to Paris for examination. Thereupon the antiquity dealer into whose hands they had fallen loaded them into sacks, and hawked them up and down Egypt in the attempt to get a few piastres for them. After some had been lost, some ground to powder, and nearly all injured, a lucky chance brought them into hands which could appreciate them, and they now lie partly in our British Museum, and partly in other museums. These tablets, when translated, turned out to be nothing less than the archives of the Egyptian Foreign Office during the reign of Akhenaton and part of that of his father. They consist of a series of letters, written in Babylonian—the diplomatic language of the period, just as French is to-day—passing between Egypt and the various powers and cities of nearer Asia. They constitute an almost complete history of Syria in this period, in which we see the Hittites and Khabiri pressing on, detaching one by one the various members of the Egyptian empire in Asia, whose frenzied appeals to Egypt for help went unheeded by Akhenaton and his court, busy singing their hymns to the Disk in Akhetaton. The end of the story may be told here. One by one the conquests of Akhenaton's warrior fathers were lost, and despite a scene in one of the nobles' tombs which represents the Syrian tribute as still arriving in the twelfth year of the reign, no attempt was made to meet the crisis, and within twenty years the conquests of two hundred were lost.

The finding of the tablets gave promise of exciting discoveries at Tell-el-Amarna, and in 1891 Flinders Petrie made there an excavation of considerable importance. Among the town mounds he discovered the Disk-temple and the Royal Palace with its famous painted plaster pavement, which attracted tourists to the spot until, in 1913, it was virtually destroyed by a foolish native to spite a fellow-villager entrusted with its protection. In the waste-heaps of the Palace Petrie found fragments of imported painted vases of a kind known in Crete and elsewhere, while the various houses which he laid bare gave us our first knowledge of the plan of the Egyptian dwelling, and large quantities of objects of the beautiful glass for which the spot has ever since been renowned.

There is next a gap in the history of discovery on the site until 1906, when the appearance of fine objects of Akhenaton's reign in the shops of the Cairo dealers tempted a German archæological society, the Deutsche Orient-Gesellschaft, to make a trial excavation there. This gave such promising results that the Society decided on undertaking the complete clearance of the town mounds, which was begun in 1910 and was still in progress in 1914. During this time about one-fifth of the town area had been excavated and planned, very great additions had been made to our knowledge of Egyptian domestic architecture and town-planning, a wonderful group of statues in the peculiar style of the period had been found, but, it must be admitted, no very striking contribution had been made to the history of the "heretic" and his "heresy."

In 1914 the claim of the Deutsche Orient-Gesellschaft to the site naturally lapsed, and in 1920 the site was granted to the Egypt Exploration Society, then anxious to resume its excavations in Egypt, interrupted in a course of over thirty years only by the war.

The first campaign was opened in December 1920 and continued until the end of March 1921. The general plan was to continue the systematic clearing, recording, and planning of the town site, but at the same time to attempt to find the cemetery in which were buried the middle and poorer classes, as opposed to the nobles, whose rock-tombs in the cliffs have already been described.

In the town area it was observed that the German excavations had been mainly devoted to clearing the houses on both sides of a long street more than fifty yards broad, but quite unpaved, which ran from north to south near the eastern edge of the town. It therefore seemed advisable, instead of continuing farther along this street, called by our predecessors the Street of the High Priest, after one of the finest houses in it, to start from some point in it and work westward, with the view of clearing a whole block or quarter of the town, and finding the general plan on which the houses both large and small were set out. At an early period in the excavation a new street was found west of and parallel to that of the High Priest, and the systematic clearance of the block between these was begun.

Each house of any pretensions to size was situated in its own garden. This had a surrounding wall, no less than ten feet high in many cases, and contained a well (ensuring to the house its private water-supply), stables, servants' quarters, and granaries. The house itself was built entirely of unbaked mud-brick, though in a few cases limestone was used for door-posts and thresholds. The floors were all of mud-brick covered with a thin mud-plaster. The roof was of the type still seen in native houses in Egypt. Rough logs and beams were laid across from wall to wall; these were covered with smaller boughs and twigs placed at right angles to them; over these, again, were laid reeds, bound together in some cases into rough mats, and the whole was surmounted by a thick layer of mud.

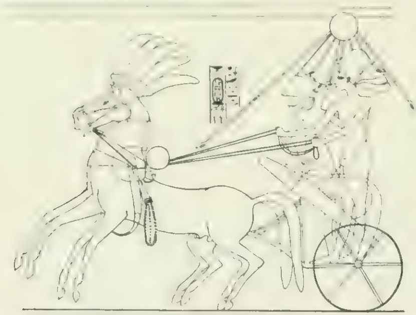
The arrangement of rooms was simple. In the centre of every house lay a square room which we may call the Central Hall. As it was surrounded on all sides by rooms, it could only be lighted by carrying its walls up higher than those of the surrounding apartments, and inserting small windows in them at a high level. In the Central Hall, as, indeed, in most of the larger rooms, the roof span was considerable, and so one or more columns of wood set on limestone bases were used to support the roofing material. In every Central Hall two pieces of furniture commanded notice. The first was a limestone slab with a raised edge, and on one side a small runnel leading off into a movable pot sunk in the earth. This slab was used for ceremonial ablutions, probably before meals and after a journey. The traveller stood on a small smooth block of stone, which was placed in the centre of the slab for the purpose, while water was poured over his hands and feet by servants and flowed off into the vase, which was then removed. The other striking piece of equipment is the hearth. Near the centre of the floor lay an open dish of pottery, about eighteen inches in diameter, filled with burnt charcoal, and set in the mud of the flooring, here raised a little for the purpose.

A TYPICAL HOUSE AFTER EXCAVATION. PART OF THE GREAT AMPHITHEATRE FORMED BY THE SANDHILLS OF THE EASTERN DESERT IS SEEN IN THE BACKGROUND.

(Reproduced by courtesy of the Egypt Exploration Society.)

To the north and west respectively of the Central Hall lay two rooms exactly alike. These have been called the North and the West Loggia respectively. The name "loggia" seems suitable, since each room is long and narrow, with a window so large and so long as to lay the room half open to the weather. The occurrence of two similar rooms has been explained on climatic grounds. In the summer the West Loggia would be insufferably hot during two-thirds of the day, while in the winter the North Loggia would on many days, as anyone who has lived in Egypt will testify, be very uncomfortably cold. With two loggias all extremes of climate could be met. The entrances to the house, usually two, lay through the loggias, which were approached from outside up a few shallow steps and through a small anteroom.

South and east of the Central Hall lay the domestic quarters, and the bathroom, which was always present in a good house. The bath was precisely similar to the ablution slab in the Central Hall, but it was often fixed in a corner with side-slabs of stone to protect the mud walls from the splashing. The only other feature of the house which demands notice is the flight of steps which invariably led up from the Central Hall to the roof, where it appears that much of the domestic business was done.



KING AKHENATON AND HIS QUEEN HEFERTITI, IN THEIR CHARIOT, WITH THE RAYS OF THE SUN'S DISK SHINING ON THEM.

(Reproduced by courtesy of the Egypt Exploration Society.)

Outside the house the most striking features are the well, which has a narrow winding flight of steps leading to a platform halfway down, where the girls stood to draw up the water from below, and the granaries, round brick structures, sunk about three feet into the ground, and rising six feet above it, with domed tops. In the gardens were found deep pockets of Nile mud sunk in the sand in order to give sustenance to the trees which provided the noble with shade in the heat of the day. A small summer-house beside the well was a feature of many of the larger gardens.

Many houses carried on their door-posts short hymns of praise to the Disk, followed by the names and titles of their owners. Thus the finest house found was in this way identified as that of the Master of the King's Horse, Ranefer. Among the numerous objects discovered in the houses were three silver vases and three bottles of beautiful variegated glass, one of which was in the form of a fish.

The search for tombs was begun in a group of low sandy hills at the foot of the desert cliffs, two miles east of the town. Some brick structures visible in the surface of the sand were excavated and found to be not, as was expected, tomb-shafts, but rooms of small houses. The extension of this excavation resulted in the discovery of a small village completely surrounded by a thick wall. It is difficult to guess the purpose of such a fortified place in this spot. There are, it is true, outlying fortresses to the north and south of Akhetaton, commanding the two narrow passages between the cliffs and the Nile which are the sole entrances into the El Amarna plain; but it is hard to believe that such a fortress could have been built to the east, attack from the desert being unlikely, and the village being in a very unsuitable position for defence. The complete excavation has been left for the next campaign. The main interest of the place, apart from the fact of its being fortified, lies in the fact that, unlike the main town site, it has not been visited by the white ant, and thus practically all the wooden portions of the houses are in almost perfect preservation. Among the most interesting objects found were portions of hand-looms, which, when further excavation has added to their number, may tell us much about the Egyptian system of weaving. But the most striking find was that of a kitchen, left untouched since its last use thirty-three centuries ago, with unused fuel, water-jar, bread oven, cooking-pot, roasting-place, and poker complete.

In the hills overlooking this village there were at the same time discovered a number of small buildings at once recognised as tomb-chapels. An Egyptian tomb always consisted of two parts, a burial chamber in which the body lay, and a chapel in which the daily offerings to the dead owner were made. In this case the tombs lay behind the chapels, farther up the slope. They were vertical shafts cut in the soft rock, with chambers opening off the bottom. Many were unfinished, and from those which had been used the bodies had been removed in antiquity, probably when the court abandoned Akhetaton and returned to Thebes. In one of these chapels a surprise awaited the excavators. On the wall was a funerary prayer, not to the Disk, but to Amon, and in the innermost shrine was a gravestone or stela set up by one Ptahmay, who calls himself "the approved one of the Disk," and who yet makes his prayers for offerings in the tomb not to the Aton, but to the deities Shed and Isis. We must not regard these facts as evidence of Akhenaton's polytheism. This chapel almost certainly dates from the period when the "heresy" of the Disk was nearing its fall, and the good citizens of Akhetaton, seeing which way the wind blew, were anxious to propitiate the old gods whose restoration they already foresaw. And they were shrewd calculators. Within a very few years of Akhenaton's death, after an ephemeral reign by Sakere, who had married the King's eldest surviving daughter, King Tutankhaton, who had married the second, abandoned the Disk-worship and returned to Thebes and to Amon-Ra. And thus, after a brilliant life of only twenty years, the "Horizon of the Disk" was given over to the sand, which in a few generations overwhelmed it and so preserved it to be disinterred by the inquisitiveness of the twentieth century A.D.

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New Methods of Criminal Investigation

Poroscopy and Graphometry

By G. Frederic Lees

POROSCOPY

FINGER prints as a means of identification in criminal cases have long been held to constitute evidence of the most irrefutable character. For the intricate pattern of curved lines we bear on our hands is never identical in two different persons. You would not find two dactylograms[1] alike, says Galton, one of the most eminent of the founders of this branch of science, if you were to examine a series of 64,000,000; and later criminologists, notably Balthazard, have come to the conclusion that this is an understatement of the truth. Moreover, from birth to death, the finger prints of a human being never change. No alteration is possible, either pathologically or by deliberate choice. It is not possible for anyone to hide his or her identity by destroying those multitudinous patterns on fingers and palms by the use of chemicals, by burning, or by constant rubbing—all practices which are resorted to by the criminal classes. Therefore the malefactor who leaves behind him on the scene of his operations, as he rarely fails to do, a single well-defined finger or palmary print, supplies the police with as faithful a portrait of himself as it is possible to have, and at the same time, presuming he has been arrested on suspicion, an undeniable proof of his guilt.

Stated thus, theoretically, the problem of criminal investigation and identification looks very simple, but in practice all kinds of difficulties are encountered, introducing an element of doubt which has had such weight with some juries that they have rightly refused to convict. The principle generally admitted among judicial authorities is that identity between two finger or palmary prints is incontestable when at least a dozen guiding marks, consisting of the beginnings of lines, bifurcations and islets, are in every respect the same. To be able, however, to come to this clear conclusion, it is necessary to have a fairly large portion of a print under the microscope, and unfortunately the traces which are so carefully collected by the experts of police laboratories on the scene of a murder, burglary, or other offence, are often very fragmentary. Sometimes, too, they are partly obliterated by the prints of persons who have arrived there before the police. Or, again, the criminal may have taken the precaution to cover his hands with gloves or cloth, in which case he may leave but a very small number of utilisable guiding marks behind him.

Supposing that only a very fragmentary finger or palmary print is under examination, showing no more, say, than three or four points of comparison with the print from the hand of a suspected person, is there any other means of arriving at a proof of guilt? Writing in *La Province Médicale* as long ago as 1912, Dr. Edmond Locard, the Director of the Police Laboratory of Lyons, was the first scientist to answer this question in the affirmative. "I believe it is possible, in many cases," he wrote in the course of a detailed statement of this new method of identification, "to make up for the insufficiency of the print considered from the sole point of view of its guiding marks by studying in the trace under examination the arrangement of the pores." Here we have a method—brought to perfection since 1912, and only recently set forth by this distinguished investigator in a work which ought to be translated into every language—which is infinitely more fruitful

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[1] The technical name for finger prints. The subject is called *Dactylography* or *Dactyloscopy*.

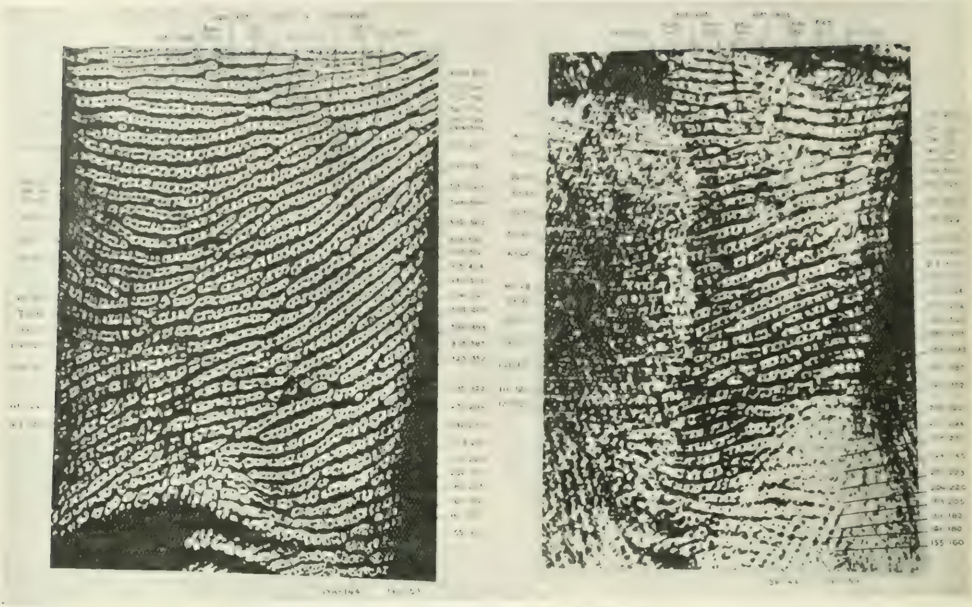

Fig. 1.—COMPARISON OF FINGER PRINTS.

The points wherein the second is shown to correspond with the first are indicated by the numbers in the margin.

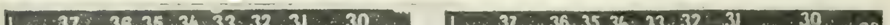

Fig. 2.—IDENTIFICATION BY POROSCOPY.

Even the smallest traces of finger prints can be photographed up to show the pores. In the above reproduction identity of the two impressions is seen to be unmistakable.

in results than the one known by the name of dactyloscopy. Like the patterns on the fingers, the pores between those patterns are unchangeable. Moreover, in shape and in size they are extremely variable, and when the trace of these sudoriferous glands has been enlarged by microphotography, we are provided with an infallible means of identification. The smallest portion of a finger print may thus be utilised, for there are from nine to eighteen of these glands per millimetre. Between one person and another there is also infinite variety in the distances between the pores. "In brief," says Dr. Locard, "the pores, because of their immutability, permanency, and variety, constitute a sign of identity of the first order. Poroscopy (as this science is called), the only method of identification in the case of very small fragments of prints, is, in all cases of dactyloscopic analysis, an important complementary proof. A jury, unimpressed by thirty or forty homologous characteristic points, will be struck by the concordance of shape, position, and number of some hundreds of pores found to be identical in two compared prints. Poroscopic research, which is difficult and hard to carry out on the original traces, even by the use of a lens enlarging five times, is practised by means of large photographic enlargements. With an enlargement of sixteen the work is already easy. For demonstration before a jury one can usefully enlarge up to forty-five times. In practice, poroscopy has very often enabled fragments of prints measuring but a few square millimetres to be used, or half-effaced prints in which only a few points were visible. Above all, it enables one in numerous cases to be clearly affirmative, and strengthens the evidence due to dactyloscopy in a most efficacious manner."

Dr. Locard cites a large number of cases in which this fresh advance in criminology has been successful. As a good example we may take the Boudet-Simonin case, in which two men with these names were arrested on a charge of burgling a flat in Lyons, on June 10, 1912, and stealing a quantity of jewellery and 400 francs. There were no witnesses of the robbery, and nobody could furnish the slightest piece of information regarding the burglars. But a rosewood cabinet, from which the jewels and money had been taken, was literally covered with finger prints. These were revealed by the aid of carbonate of lead and photographed. Search was then made in the finger-print archives of the Lyons Police Laboratory, with the result that certain prints were found to be identical with those of a man Boudet, who had been several times convicted of theft. The man's record at the Sûreté showed that he often worked in collaboration with a man named Simonin. Both were arrested. And it was then found that the finger prints which were not Boudet's were Simonin's. Thirteen prints from the former's hand presented 78 characteristic points; 2 prints made by the latter, including that of the palm of his left hand, showed 94 points of comparison. In the case of the middle finger of Boudet's left hand 901 pores were identified, while in that of Simonin's palm more than 2,000 homologous pores were pointed out to the jury. On this sole piece of evidence the men were sentenced to five years' hard labour, the jury refusing to grant them the benefit of extenuating circumstances. "I am convinced," comments Dr. Locard, "that the demonstration of the homology of the pores played, in the minds of the jurymen, the principal rôle."

Stockis, another well-known criminologist, proved experimentally that the wearing of leather or india-rubber gloves need not prevent the formation of finger prints, and in February 1912, in the S—— case, Dr. Locard put theory into practice by identifying a gloved burglar without any other proof than his finger prints. The print was naturally less clear than that of a bare hand, but nevertheless a fairly large number of guiding marks could be distinguished.

GRAPHOMETRY

Another new method of criminal investigation, which has rightly been declared to be even more mathematical and more scientific than poroscopy, is also due to the science and ingenuity of the head of the Lyons Police Laboratory. It goes by the name of graphometry, and is applied to the recognition of written forgeries. The alteration of a document by means of scratching out, writing over the top, or by tracing can easily be recognised by microscopic examination. X-rays also have been employed to reveal other instances of tampering with documents. But when there is merely imitation of handwriting, and this imitation is apparently perfect, identification of the forgery becomes difficult. How to unmask the forger in such a case as this was the problem which Dr. Locard set out to solve, with complete success.

Dr. Locard's method of revealing the identity of the forger or writer of anonymous letters is based on the fact that there are peculiarities in the handwriting of everyone which cannot be reproduced by the forger, who, whilst attempting to imitate perfectly, involuntarily introduces his own peculiarities into the script. Graphometry, then, consists in decomposing a given piece of writing into measurable elements, and afterwards proceeding to make rigorous comparisons of numbered values. The complete technique of the method cannot possibly be given in a magazine article; but the main principles, illustrated by two or three examples, can be indicated.

These principles are based on four methods of analysis which take into consideration the height of a given writer's *grammas*, the directions in which these slope, his interruptions—that is, the number of times he raises his pen from paper, etc.—and the various shapes of his *grammas*. Let me here note .that this new word *gramma*, used by Dr. Locard, means any written character, figure, or sign, and is less apt to lead to confusion than the word "letter" or "character." Height is interpreted by measurements. A given writer, according to the pen he is using, the space at his disposal, and the nature of the text he is writing, traces *grammas* which are sometimes small and sometimes large, but the relation between the height and the breadth of each *gramma* remains constant. The slope of his *grammas* is interpreted by angular values. The frequency with which a writer lifts pen from paper can be calculated and represented graphically by means of curves. And finally, shapes can also be interpreted statistically and translated into comparable curves. The superposition or divergence of the curves thus furnished by two writings makes striking comparisons.

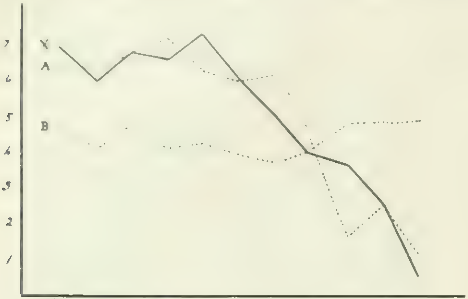

FIG. 1. (GRAPHOMETRY.)

As an example of the first method Dr. Locard takes the word *remerciement* in an anonymous letter (text X) the author of which has to be discovered. The same word occurs in the texts to be compared with it, or in those dictated to two persons, A and B, who are under suspicion. After the various measurements have been made, the chart Fig. 1 is the result. Clearly the writer of the texts X and A are one and the same; B's writing is entirely different. Naturally, it is only after a number of words have been analysed in this way that a definite conclusion is arrived at.

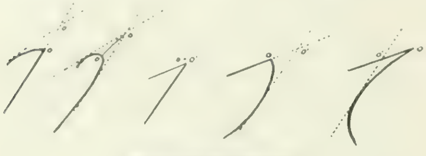

FIG. 2. (GRAPHOMETRY.)

Variations in the curves of *grammas* are very characteristic, and one of the methods employed in measuring the angles is shown by Fig. 2.

The direction of the slope of the *grammas*—otherwise known as *parallélisme grammatique*—is well shown *graphically* by the word *meurtre* (Fig. 3), the up and down strokes being prolonged until they intersect.

Graphometry in such expert hands as those of Dr. Locard and his assistants is of the greatest value in the detection of the forger or malefactor. Its application has already on numerous occasions met with success, and notably in the case of a post-scriptum to a letter written by a dying soldier at the front—a post-scriptum which, properly legalised, left the whole of his possessions to the receiver of the letter. It was shown by means of the methods outlined above that the same person could not possibly have written both letter and post-scriptum, and Dr. Locard's demonstration was so convincing that the forger at last confessed.

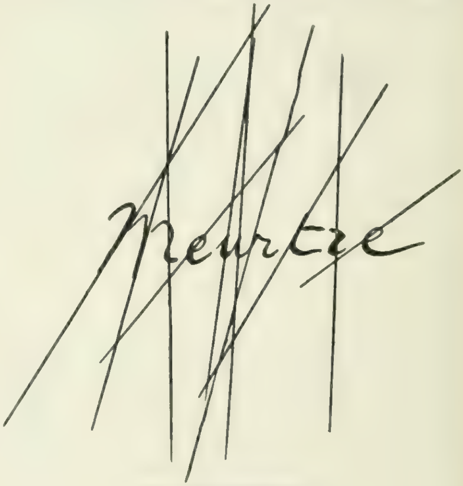

FIG. 3. (GRAPHOMETRY.)

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New Light on Old Authors

III. The Proscription of 43 B.C.

By R. S. Conway, Litt.D., F.B.A.

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Most of us have, at some time or other, read Shakespeare's *Julius Cæsar*. But one scene in it, which is grim enough when its meaning comes home to us, is apt to pass away quickly from the memory, because it is rather isolated where it stands in the play. I mean the few lines in Act IV in which Antony, Octavius, and Lepidus confer as to the "Proscription."

> *Ant.* These many, then, shall die; their names are pricked.
> *Oct.* Your brother too must die; consent you, Lepidus?
> *Lep.* I do consent—
> *Oct.* Prick him down, Antony.
> *Lep.* Upon condition Publius shall not live,
> Who is your sister's son, Mark Antony.
> *Ant.* He shall not live; look, with a spot I damn him.

The object of this paper is to sketch some aspects of life in Italy during that reign of terror, partly by the help of an inscription which was anciently engraved on marble at Rome, and of which an important part has been recently discovered.

Several large fragments of marble containing what appears to be the eulogy of a husband upon his wife had long been known[1] in Rome, although unluckily only two of the fragments themselves are preserved, the rest being known to us only from copies made after their first discovery. But in 1898 another fragment was found, the contents of which clearly showed that they belonged to the same monument. The inscription is an authentic piece of Roman literature unique in its kind. The style of the writing and the contents alike make it certain that it was set up in the time of Augustus; but the whole offered a kind of historical missing-word puzzle, because the first few lines, which no doubt contained the names of the people whom it concerned, were broken away and lost, so that the inscription was (and is) like a dog that has eaten his label; we could not tell to whom it was to be ascribed. No part of the surviving fragments gives us either the name of the husband or the name of the wife he mourns, though they tell us a great deal else about them. Now, the historian Appian, who wrote in Greek in the second century A.D., included in Book IV of his *History of the Civil Wars*[2] some details of the Proscription in 43 B.C., and scholars have been able to pick out from these a particular Roman noble called Quintus Lucretius Vispullo, whose story tallies with that of the monument. The same story is recorded more briefly by Valerius Maximus,[3] who gives the wife's name as Turia.

Vispullo, then, it was who engraved on marble, at what must have been great cost, a biography of the wife with whom he had lived, as he tells us, for forty-one years, and thanks to whom he had escaped the deadly peril of having been put upon the list of the proscribed. But before we turn to Turia herself, we must try to form some conception of what the Proscription actually was.

After the murder of Julius Cæsar on the "Ides of March" 44 B.C., Mark Antony seized on all his papers and property; and by his eloquent speech to the people drove Brutus and Cassius and the other conspirators to what amounted to exile in Asia Minor, while he departed to govern (and tax) the provinces of Gaul. The Senate hesitated, but at length, roused by Cicero and supported by Octavian, Cæsar's heir, a youth of nineteen who as yet held no political office, decided that they must resist Antony's pretensions. Accordingly the two Consuls, Hirtius and Pansa, with Octavian, raised an army and defeated Antony at Mutina (now Modena), in April 43 B.C.; but Hirtius and Pansa fell in the battle, and Antony and Octavian at once made terms with one another and with Lepidus, another general with an army in the North. One of the conditions on which their compact was formed, a compact which we generally call the Second Triumvirate, was the "Proscription," by which each secured the death, and the confiscation of all the property, of his particular enemies. This list was agreed upon by Antony, Lepidus, and Octavian, at two long sittings, Octavian having at first resisted Antony's demand for the death of Cicero, with whom he, Octavian, had been in most friendly relations since Cæsar's death. However, Octavian gave way, and the Triumvirs marched to Rome at the head of their armies and proclaimed peace; but the first act of the peace was to set up a list of persons—very few of whom had taken part in the Civil Wars or in politics, but all of whom were wealthy—who were to be hunted to death like beasts.

The actual words of this document have been preserved by Appian, and are worth translating here:

"We, Marcus Lepidus, Marcus Antonius, and Octavius Cæsar, having been elected to bring into harmony and order the affairs of the Republic, make the following proclamation. But for the treachery with which disloyal citizens, who had obtained mercy when they prayed for it, nevertheless became enemies of him who had shown them kindness and conspired against his life, Gaius Julius Cæsar would never have been slain by those whom he took prisoners in war and mercifully spared and whom one and all he had treated as friends and promoted to honours; nor should we now be compelled to take these measures against all those who have insulted us and proclaimed us public enemies. But as things are, seeing that the wickedness of those who have plotted to destroy us, and by whom Cæsar was slain, cannot be overcome by any kindness, we choose to anticipate our enemies rather than to suffer ourselves. Therefore let no man think that what we do is unjust or cruel or excessive, when he remembers the fate of Cæsar and the wrongs[1] that have been done to us. Cæsar was Dictator and High Priest, and had vanquished and subdued the nations that were most dangerous to Rome, and first of all men had begun to explore the unknown sea beyond the pillars of Hercules, and discovered the land of Britain, hitherto unknown to Rome; yet they slew him in the midst of what they call the sacred Senate-house, under the eyes of the gods, defacing his body with twenty-three wounds, though they had all been taken prisoners by him and spared, and though some of their names were written in his will as his heirs. But the rest, instead of punishing the authors of this abomination, raised them to office and honours, which they abused by seizing on public money[2] for themselves, and levying an army against us. . . . Some of them we have already punished; the rest with God's help you shall shortly see chastised. We have already succeeded in the greatest of our endeavours, and made subject to us Spain and Gaul, and the districts nearer home. One task yet remains: to make war upon the murderers of Cæsar who are across the sea.[3] And since we intend to conduct this war at a distance on your behalf, it does not seem to us to be safe either for us, or for you, to leave the rest of our enemies here behind us, since they would take advantage of our absence, and lie in wait for the accidents of war. Nor do we think that, in the present emergency, we ought to be slow to act from any consideration for them, but rather we must put them one and all out of the way. We have no grudge against any large body of citizens, nor shall we make[4] any choice of our private enemies nor shall we in the least single out those who are wealthy or politically eminent, though it must needs be that three men must have more enemies than one; we shall not slay as many as did the last Dictator whom you called Sulla the Fortunate, although he too was called on to rule the city during a civil war. And though we might arrest those whom we know to be evil without warning, we prefer rather to proclaim their names for your sakes, so that, having them properly named and numbered, the soldiers may abstain from interfering with anyone else. Therefore, with the blessing of Heaven, we give command that none shall receive any of those whose names are written below. Whosoever shall attempt to save them is included in the list. And whosoever shall bring the head of any one of them to us, if he be a free man, shall receive 2,500 drachmæ,[5] but if he be a slave he shall receive 1,000 drachmæ, his freedom and all the civic privileges of his master. The same reward shall be given to anyone who shall give information of their place of hiding. We shall not enter on our records the names of any who earn these rewards."

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[1] *Corp. Insc. Lat.*, vi. 1527 and 31670.

[2] This book is now included in the Loeb series of translations.

[3] In Book VI. 72 of his collection of "Memorable Deeds and Words," dedicated to the Emperor Tiberius (A.D. 14–37).

Then followed the 2,000 names of the victims.

Did ever murder speak so loud? The writing was doubtless that of Antony, but the signature is Octavian's too. Yet within three years of this, Vergil published his Fourth Eclogue, a half-boyish dream of a new era of peace.[6]

Now consider the fate of the venerable patriot and orator Cicero, as related by Plutarch[7]:

" At last he put himself in the hands of his servants, and ordered them to carry him by sea to Caieta, where he had a delightful retreat in the summer. There was a temple of Apollo on the coast, from which a flight of crows came, with great noise, towards Cicero's vessel, as it was making land. They perched on both sides the sail-yard, where some sat croaking and others pecking at the ends of the ropes. All looked upon this as a bad omen; yet Cicero went on shore, and, entering his house, lay down to repose himself. On sight of this the servants began to reproach themselves. Then partly by entreaty, and partly by force, they got him into his litter, and carried him towards the sea.

Meantime the assassins came up. They were commanded by Herennius, a centurion, and Pompilius, a tribune, whom Cicero had formerly defended when under a prosecution. The doors of the house had been made fast, but they broke them open. Still Cicero did not appear, and the servants who were left behind said they knew nothing of him. But a young man, named Philologus, a freedman of his brother Quintus, whom Cicero had instructed in the liberal arts and sciences, informed the tribune that they were carrying the litter through a deep wood to the seaside. The tribune, taking a few soldiers with him, ran to the end of the walk where Cicero's party was to come out. But Cicero, perceiving that Herennius was approaching to meet him, ordered his servants to set the litter down [though a large number[8] of them had gathered and were preparing to defend him by force], and putting his left hand to his chin, as it was his custom to do, he looked steadfastly upon his murderers. Such an appearance of misery in his face, wasted with anxiety, so much affected the attendants of Herennius that they covered their faces. Cicero stretched his neck out of the litter to receive the blow, and Herennius slew him. Thus fell Cicero, in the sixty-fourth year of his age. Herennius cut off his head, and, by Antony's command, his hands too, with which he had written the Philippics (denouncing Antony's crimes).

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[1] These "wrongs" are only Antony's way of describing the resistance of the Senate to his own armed attempts to make himself emperor.

[2] If there was any truth at all in this charge, it could only relate to provincial revenues. Antony himself had left no money in Rome for anyone else to seize. It was, of course, Antony whose armies were unconstitutional; the senatorial forces were perfectly legal.

[3] That is, Brutus and Cassius.

[4] This and the following clause, *if the negatives be removed*, describe exactly what were the principles on which the list was made up.

[5] Roughly £100, though with a very much greater purchasing power than that amount of money to-day.

[6] On this poem see DISCOVERY, May 1920.

[7] Langhorne's translation, p. 614.

[8] This detail is from Appian.

When these parts of Cicero's body were brought to Rome, Antony happened to be holding an assembly for the election of magistrates. He ordered the head and hands to be fastened up over the Rostra, a dreadful spectacle to the Roman people, who thought they did not so much see the face of Cicero, as a picture of Antony's soul."

A glimpse of the outrage inflicted on altogether innocent people is given us by the story of a man called Restio. He had escaped with one slave who had once been a favourite servant, but who had in some way misbehaved himself so that his master had branded him. Restio was startled to find that this slave had followed him, and expected that the slave would now avenge himself by turning informer. The slave, however, told him not to be alarmed because he had not forgotten all the kindness he had received before he was branded, and so took his master to a cave and secretly supplied him with food for several days. Then as he found that several people in the place had begun to suspect his master's retreat, and discovered that a body of soldiers was seeking for him, the slave ran after an old man whom he had noticed going alone along the road, cut off his head, brought it to the soldiers and claimed the reward. The soldiers gave the slave nothing, but snatched away the head, so as to secure the reward for themselves, and hurried back to Rome. The slave then succeeded in getting his master safely off to sea.

The stupidity of the murderers appears very plainly in the proclamation of one of the Triumvirs, Lepidus, who wished to celebrate a Triumph for victories that he had won in Spain; expecting, naturally enough, that people would be in no mood to engage in any public rejoicing, he put up this proclamation: "With the blessing of heaven, all good citizens, male and female, are to offer sacrifice, and observe this day as my festival, and anyone who is found not openly rejoicing shall be included in the list of the proscribed." He conducted his procession amid loud cheers.

And there are some absurdities of a less grim kind. A man called Pomponius, whose name was on the proscribed list, arrayed himself in his full robes of office as a general, and dressing his slaves as lictors, marched through the streets of Rome with these men round him, at the gates demanded public chariots to carry his party, and so made his way through Italy, everyone giving him in terror what he wanted; finally he secured one of the ships of the navy to sail to Sextus Pompey, since he alleged that he had been sent to make peace with him on behalf of the Triumvirs.

Perhaps the most daring device which led to an escape was that of Ventidius, whom we hear of afterwards as a successful commander. He dressed himself up as a centurion, put himself at the head of a force of soldiers, and marched wherever he liked in Italy, searching for a man whose name was on the proscribed lists and whom, strangely enough, he could never find;—the man he was searching for was himself!

Two samples of the devotion of slaves to their masters should not be omitted. The names of the slaves are not even known. A favourite slave of Appius, hearing that the soldiers were searching for his master, dressed himself up in his master's clothes and lay down on his master's couch, with his back to the light. The soldiers came and killed him, but the delay enabled his master to escape. And a man called Milennius escaped by the similar devotion of another slave, who dressed himself as his master, entered his master's sedan-chair, and persuaded his fellow-slaves to carry him off in it and to break into a run just as the soldiers came into sight. They, seeing the litter being carried off, rushed after it and killed the faithful slave. But Milennius managed to escape.

Now turn to the story of Quintus Lucretius Vispullo himself, as Appian tells it.

Vispullo was wandering about the country with two good servants, but through lack of supplies was forced to turn homewards, riding in a litter as a sick man. But one of his bearers had injured his leg, so Vispullo had to walk, leaning on the other. As they came in sight of the gate[1] he saw a troop of soldiers running out; and, remembering that his father had been caught on that very spot in the proscription of Sulla, he turned aside with one of his servants to hide in one of the tombs that stood beside the road. There they were safe until the evening, when they were visited by a party of tomb-robbers. But this faithful slave gave himself up to be stripped of all he had to allow his master to escape. But Vispullo waited for him at the gate, and shared his clothes with him; so they safely reached his house in Rome, where his wife concealed him between the two parts of a double roof, until at last some friend succeeded in getting his name removed by Octavian from the list of the proscribed.

The identification of Vispullo with the author of the inscription has been worked out very carefully by Mommsen, whose commentary[2] on the chronological, historical, and legal points of the case left really nothing

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[1] Anyone who has been at Rome will remember how straight a course the Appian Way keeps for miles outside the gate.

[2] See his notes in the *Corp. Inscc. Lat.* at the places already cited.

[illegible] for later scholars to add. But on the literary side of the inscription—in other words, on its interest as a record of human character and feeling—he has not a word to say. It was quite characteristic of the great Prussian to feel no interest in that. Not the least of the services rendered to letters by the late Dr. Warde Fowler was the chapter in his *Social Life at Rome* in which he dealt with the inscription from this point of view; and to this the reader may be referred for further details.

The inscription from which I will now translate a few paragraphs was erected by Vispullo himself in memory of his wife when she died, after they had enjoyed many years of life together under the firm but peaceful rule of the mature Augustus. The inscription is written in praise of the dead lady, but it differs in a characteristic way from other ancient sepulchral eulogies in that it is addressed, not to the passer-by, nor to the public, nor to the family of the dead or of the speaker, but to the dead lady herself; so that it has an intimate tone very unlike that of a funeral speech.

"Such long union as we enjoyed, ended only by death, is rare, for we lived happily together for forty-one years, and you left me only to wish that the parting had come by my death and not by yours, as would, indeed, have been natural since I was the elder. I need not speak of all the good qualities which you shared with other true wives, your faithfulness, obedience, courtesy, and good humour; your assiduity in spinning and weaving, your religion without superstition, your inconspicuous dress and modest way of life, your affection for your own family, your kindness to your household, which you extended as much to my mother as to your own parents. But some qualities I must claim as having been peculiarly your own, and they are such as Fortune has made rare in human experience."

He then mentions various examples of her liberality and her administrative powers; and proceeds to describe how she had saved him on two separate occasions in the Civil War. The first appears to have been in 48 B.C., when Vispullo left Italy to join Pompey when he fled to Pharsalia; Vispullo was then put in command of Pompey's fleet in the Adriatic, which in vain attempted to prevent Cæsar's crossing. On this occasion Turia gave him all her pearls and personal ornaments, and not only continued to send him fresh supplies from the estate, but defended the house first from a troop of Julius Cæsar's army—until Cæsar called them off; and then a year later (47 B.C.) from what seems to have been a siege by Milo, who was then wandering about the South of Italy with a band of cut-throats. This incident is related on what survives of the fragment most recently discovered. Of his own later deliverance and his wife's share in it Vispullo writes thus:

"I can hardly persuade myself to bring into the light of day our dearest and most tréasured memories, by telling how I was saved by a sudden message which you sent me warning me of pressing danger; you refused to let me make the rash attempt to escape from Italy, and persuaded me to adopt wiser counsels; you prepared for me a safe hiding-place, taking your sister and her husband into the secret, though thus they also took a share in my danger. I could not tell the whole story if I tried. It is enough to record that you saved[1] me. But I will confess that the bitterest experience I ever suffered was after my restoration had been granted by the generous decision of Augustus Cæsar, at a time when he was absent from Rome. For then you boldly requested his colleague Marcus Lepidus, who was in Rome, to carry out my restoration. But when you bowed before Lepidus he not merely refused to lift you up, but ordered you to be dragged away and hustled and beaten like a slave. Your courage was not subdued and you forced him to recognise Cæsar's edict, openly protesting against his insult, so that the world might know who had been the author of the danger in which I stood. And it was not long before that author had reason to regret what he had done. . . . When peace was restored to the world and quiet government re-established, happy times fell to us too. We longed for children, which Fortune for a time had grudged us. And if only Fortune had continued the kindness which she began to show, we should have lacked no happiness; but her decree was otherwise."

Vispullo then passed to what seems to have struck him as one of the greatest of his wife's virtues, and we can at least realise the unselfishness of her attitude. From the phrase which follows we gather that they lost their only daughter soon after she was born; some years after that Turia made to her husband the proposal that he should divorce her in order to marry some wife who might bear him children, promising that she would treat the new wife like a sister and her children as if they were her own kin. Whatever we may think of this suggestion, Vispullo knew quite well what he thought. "I must confess that I was almost out of my mind to think that any divorce between us could be made except by death; that you should dream of ceasing to be my wife while you still lived, when you had been faithful to me all the years during which I had been almost a banished man. What desire or need had I of children that I should break my faith to you and sacrifice a certain for a doubtful happiness? I could not have yielded to such a suggestion without dishonour to myself and misery to us both."

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[1] This reticence is interesting. Vispullo seems to have felt that the actual details of his concealment would be out of harmony with the dignified grace of this record, which was to be engraved on marble.

He then relates how in accordance with Turia's own desire he had adopted a daughter, and this is how the long inscription ends:

"I might dwell on all your forethought and good counsel, but I must reserve this space rather for a tribute to your goodness, so that at least I may show how deeply I lament the wife whose memory I have sought to consecrate for ever. Do not think that your example will be forgotten, for your fair renown meets me at every turn and teaches me to be brave against ill-fortune. Fate has not robbed me of everything since it still suffers me to cherish the memory of your goodness, though I have lost all the peace of my soul in losing you. When I think how you were wont to foresee and provide against my dangers, I am broken down with the thought of my calamity, and I cannot be faithful to my promise not to grieve. Grief overcomes my resolution, and I am plunged in sorrow whether I look forward or backward; and the very greatness of your memory makes the rest of my life promise nothing but days of mourning. My last word shall be that there was nothing which your goodness did not deserve, but that I never succeeded in paying my debt. I have counted your last commands as a law, but I will spare no honour which they did not forbid me to render you. And now I pray that the gods with whom your spirit is give you peace now and for ever."

The Study of Plankton

By J. Travis Jenkins, D.Sc., Ph.D.

Marine organisms can be roughly divided into three groups according to their mode of life; the *plankton*[1] or drifters, the *nekton* or swimmers, and the *benthos*[2] or fixed organisms. The division is very convenient for students of marine life, but it must not be pressed too far, since many animals and plants belong to one group at one stage of their life-history, to another group at another stage. To the first group, the *plankton*, belong all those creatures which, owing either to their small size or feeble muscular development, are unable to make any headway against a current, but drift about at the mercy of the wind and tide. Only quite recently has the importance of this group been recognised; it is now generally regarded as the source of all organic matter in the sea.

Nearly all marine animals or plants are represented at some stage or other of their life-history in the plankton. Life swarms in all the surface layers of the ocean that are penetrated by sunlight. This life depends ultimately on the power which marine plants possess of manufacturing organic substance from inorganic by means of their chlorophyll corpuscules, the energy being supplied by sunlight. Most people have an erroneous idea of marine plant life. The floor of the ocean is not covered with marine forests. Only along the comparatively limited area of the littoral zone is there any growth of fixed marine plants. By far the greater quantity of marine plants are microscopic in size, they float in the surface layers and consequently belong to the plankton. They are the true pastures of the sea, and upon their abundance all animal life depends, including our food fish of economic importance, and, consequently, our great sea fisheries.

There is therefore no reason for surprise that the plankton has been extensively studied during the last decade or so, and voluminous works have been published dealing with this branch of marine biology. The plankton group is of enormous extent and astounding variety. The skeletal remains of former planktons form vast deposits on all the ocean floors. These planktonic deposits are found nearly everywhere, except where the solvent action of the salt water has removed the bulk of the skeletal remains. The various oozes—*Diatomaceous*, *Radiolarian*, and *Globigerina*—are derived from the remains of planktonic organisms.

The abundance of the vegetable plankton depends on the presence of certain chemical elements in the sea-water. Where these elements are present in the greatest abundance the plankton is richest.

Many open-sea fish live directly on the plankton. These plankton-eaters, which include the herring, sprat and mackerel, are provided with comb-like structures—the gill-rakers—which are attached to the gills and act as food strainers.

When the fish breathes, water is taken through the mouth and passed out over the gills, and during this process minute organisms of the plankton are retained by the gill-rakers, whence they are washed off by the fish's tongue and swallowed. If the contents of the stomach of an open-sea fish such as a mackerel be examined, they will be found to consist of planktonic crustacea; as, for instance, the young of the hermit crab, the second stage in the development of the Norway lobster (*Nephrops*) and prawns (*Palinurus*).

The various organisms met with in the plankton are now well known. Not only have they been identified and described, but chemical analyses of the group have been made and comparisons with land animals and plants instituted. We have already noted that nearly all marine animals are represented in the plankton at some stage or other of their life-history. Fish are found in the egg and larval stage. With the exception of the herring, all our food fish of economic importance lay eggs which are lighter than sea-water and which, therefore, float upwards to the surface layers where they are found in great abundance in the spring months of the year. The two great families of economic value, the Cod family (*Gadidæ*) and the Plaice family (*Pleuronectidæ*), are represented in the surface waters of the British Isles by many millions of eggs and larvæ every spring. These eggs may be captured by towing a small-meshed net through the water, a method in which muslin or silk bolting cloth is the material generally used. If the contents of the net be washed out and examined with a hand lens, numerous globules of gelatinous matter are readily distinguished. These are the floating fish-eggs. Many hundreds are seen in a typical haul, but it is impossible in most cases to recognise the species without careful examination under the microscope.

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[1] Literally, "tossed (by the waves)."

[2] Literally, "the great depth."

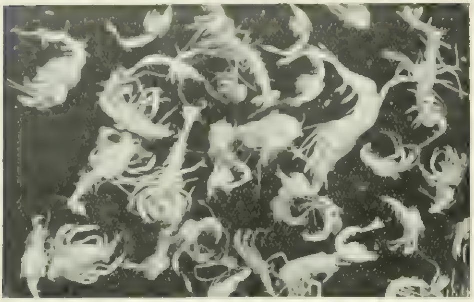
FIG. 1.—FOOD OF MACKEREL.

The egg of the plaice may usually be recognised by its large size. The cod and whiting have smaller eggs, and, generally speaking, they are surrounded by numbers of a small cope-pod crustacean (*Calanus*). Later in life our food fish belong to the Nekton, since they are able to move independently of the currents. Economically speaking, crustacea form one of the most important groups in the plankton, if we exclude fish. Some of the crustacea are represented in both their young and adult stages, others in the larval condition only. The edible crab, which passes its adult stage on the bottom (Benthos), passes through a free-swimming life-history in which two main stages have been recognised; in both of these stages it belongs to the plankton.

The first larval stage of the crab is the *Zœa*, in which the carapace, or upper shell-covering, bears a long spine. This is followed by a stage in which the body gradually assumes a crab-like appearance, though the tail is still extended, as in the lobster, and not curled up under the carapace. This is known as the *Megalopa* stage.

Even the fixed crustacea, such as the common barnacle, pass through a free-swimming larval stage, in which they belong to the plankton. The larvæ of the barnacle are distinguished by three pairs of swimming appendages and are known as *Nauplii*.

Our edible mollusca, such as the oyster, cockle, and mussel, appear in the plankton only in the larval stage. Other mollusca, such as the *Heteropoda* and *Pteropoda*, spend the whole of their life as plankton organisms.

Marine worms, generally speaking, are only found in the plankton during their larval stages, but there exist a few forms which are found only in the open sea, such as the arrow-worm (*Sagitta*). Jelly-fish, or *Medusæ*, are also members of the group. Most of the common jelly-fish are large and easily recognisable, but there are several forms which are small enough to be taken in the tow net. Two of the commonest of these small forms in British seas are known as *Pleurobrachia* and *Beroe*. The former is known to the fishermen as the "Marble-bleb," and is often taken in the shrimp trawl.

All the forms hitherto mentioned definitely belong to the animal world. Other constituents of the plankton belong no less clearly to the vegetable world, while others still are of doubtful position. So numerous are the plankton organisms that it is no exaggeration to say that every drop of sea-water near the surface contains some form of life. Countless multitudes of unicellular forms of life are encountered. The most important animal forms belong to the *Infusoria*, *Foraminifera*, and *Radiolaria*. Of the plants the most important group is that of the *Diatoms*. *Infusoria* are more common in fresh-water plankton than in the sea. Nevertheless, one of the commonest of local organisms belongs to the *Peridinians*, which are *Infusoria* provided with shells

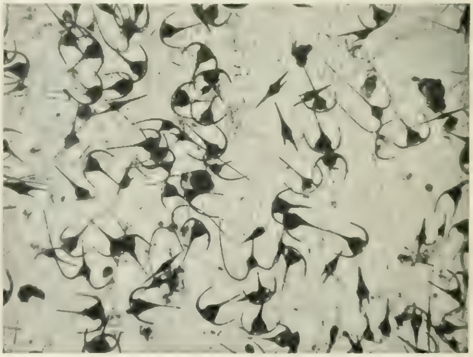
FIG. 2.—PERIDINIAN PLANKTON (*CERATIUM*)

and *flagella* (lash-like appendages). The form known as *Ceratium* is the most abundant.

The phosphorescence noticeable in the North and Baltic Seas is usually due to *Ceratium*; in the Irish Sea, on the other hand, it is due to *Noctiluca*, a flagellate infusorian which is so abundant that at times the water is discoloured by it.

Careful comparisons have been made between the productivity of the sea and of cultivated land, and it is found that the sea is about 20 per cent. below cultivated land in fertility. Further research and experiment are, however, necessary before generalisations of this kind can be made with confidence.

Standards of Correctness in English[1]

By Henry Cecil Wyld, M.A.

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(*Continued from p.* 234 *in the September number*).

The sources of our information as to the pronunciation of the 17th and 18th centuries are of three kinds —(*a*) private letters and diaries in which the writers often depart from the regular and 'correct' spelling, and unconsciously spell as they pronounce; (*b*) statements of grammarians and writers on pronunciation; (*c*) rhymes of poets. Of these the first are the best. The material they afford is very copious, and as we find the same spellings occurring several times, in the letters of different persons, they must be taken seriously; as the writers of the letters are expressing themselves in a natural unstudied manner, we almost gain the impression that we are actually listening to them speaking; further, many of the unstudied spellings, which tell us so much, are used by the writers on pronunciation of about the same time to express identical pronunciations.

The best collections of letters for our purpose are those contained in the *Memoirs of the Verney Family* (1639–1696), edited by Lady Verney, four vols., 189–; the letters of Mrs. Basire, in *Correspondence of Dr. and Mrs. Basire*, ed. Dr. Darnell, 1831 (Mrs. Basire's letters cover from 1651 to 1661); for the 18th century we have the *Wentworth Papers* (ed. Cartwright, 1883), and especially the letters therein of Lady Wentworth, her son Peter, and her daughter-in-law Lady Strafford. These letters cover the period 1705–1739.

The Verneys were an ancient county family living at Claydon in Buckinghamshire, not far from the Oxfordshire border. The letters are from Sir Edmund Verney ('the Standard Bearer'), his son Sir Ralph, the wife and sisters of the latter, his uncle Dr. Denton, and his cousins and friends, a large and representative circle. The writers of these letters are all persons of the same class—that of the wealthier squires, and in some cases peers and their wives. Some of them write from the country, others from London, where they occupied positions about the Court or in the Government. Many are travelled and highly cultivated persons.

Mrs. Basire, who belonged to an old Shropshire family of the same standing and position as the Verneys, was the wife of the Rev. Dr. Basire, a French nobleman by birth, who came in his youth to England, studied at Cambridge, took orders in the Church of England and became Rector of Egglescliff, co. Durham, and subsequently Archdeacon of Northumberland. He was exiled from this country on the fall of the Monarchy, but returned and lived happily with his family after the Restoration.

Lady Wentworth lived in the best society of her day. She had been Lady of the Bedchamber to the Queen of James II. Her eldest son, who afterwards became Earl of Strafford, was for a long time ambassador at Berlin.

All these people, then, belong to the higher ranks of society, they all belong to the same world, are persons of education and social experience, and we may take it that their speech, which, by the way, shows remarkable similarity, represents the best type of English spoken in their day. It is also the natural traditional development of the English of the 16th century, so far as we are able to form an idea of this from materials of the same kind as these letters, written by Elizabeth and her contemporaries.

I have selected for treatment the following general subjects: (1) pronunciation of consonantal sounds; (2) pronunciation of vowels in unaccented syllables.

1. PRONUNCIATION OF CONSONANTS AND COMBINATIONS OF CONSONANTS

(a) *Substitution of* -n *for* -ng *in the suffix* -ing

Much has been written, and more said, often in derision of the habit, which still survives in nearly all popular dialects and among many speakers of standard English, of saying *rainin'*, *huntin'*, *comin'*, and so on. So far from being a modern affectation, this pronunciation is found as early as the 14th century. The evidence of spellings, the statements of gram-memoirs and poets' rhymes lead me to believe that it has [illegible] increased during the 17th and 18th centuries.

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[1] Readers desiring a bibliography of the writers mentioned in Prof. Wyld's article are referred to the September number, page 234.

The Verney Memoirs have: *seein, missin, bein, comin, beggin, shillins, disoblegin, lodgins;* Cooper, one of the best writers on 17th century pronunciation (1685), says that *coughing* and *coffin*, *coming* and *cummin* are pronounced alike. The celebrated Lord Rochester (died 1680) rhymes *farthing—bear-garden*. Lady Wentworth writes *takin, dynin-room, lodgins, buildin, devertin, prancin along, fardin, mornin, writins,* and so on. Pope rhymes *gardens—farthings* (cf. Lord Rochester above).

Walker, whose authority on questions of pronunciation stood very high in his own day and for long afterwards, asserts in his *Rhetorical Grammar* (3rd ed., 1801), that the best speakers invariably pronounce *-in* when the body of the word is in *-ing*, and say *singin, bringin*, and so on, whereas even in other words they often pronounce *-in*, though he says that in this case he prefers *-ing*, 'when the language has the least solemnity,' but considers *-in* but 'a trifling omission.'

(b) su- *pronounced as* shu-

We all agree, I fancy, in pronouncing *sh-* in *sure* and *sugar*, but should hardly pronounce *suit* in the same way as *shoot*. The 17th century knew no such distinctions. The Verney Memoirs have *shur, shewer*, but also *shuite* (of clothes), *shewtid* 'suited.' Mrs. Basire has *ashoure* 'assure,' and *shut* 'suit.' Jones, a most reliable writer on pronunciation (1701), says that *sh-* is pronounced in *assume, consume, ensue, sue,* and *suet*, in addition to the words where we still pronounce it.

(c) -di- *pronounced like* -dg- *or* -dj-

In words like *tedious, immediate* we now pronounce a distinct *d* followed by a short *i*. Not so our ancestors. One of the Miss Verneys writes *teges* 'tedious' = evidently 'te-jus,' and her friend Lady Sussex writes *sogers*, a pronunciation in which many would still agree with her, except that they would not now omit the *l*. Jones indicates an identical pronunciation by the spellings *soger, Injan*. Lady Wentworth writes *emedgetly*. Walker says that polite speakers always pronounce *edjucate, verdjure, verchew*, and that they *ought* to say *ogeous, insidgeous, Injean*. Leigh Hunt records that John Kemble the actor still said *ojus, hijjus, perfijjus*.

(d) *Loss of* -d- *before and after another consonant*

Wensday is common from the middle of the 15th century onwards, and occurs in the letters of the Verneys and Lady Wentworth, besides being noted by Jones, who also says that *d* is not pronounced in *friendly, handmaid, candle, handle, kindle, children,* and so on. *Lunnon* for *London*, which survived as a polite pronunciation far into the 19th century among old-fashioned speakers, is found written *Lonan* by Mrs. Basire in 1654, is referred to by Gray in a letter to Horace Walpole (1757), and is vouched for by Elphinston (1787), a most meticulous writer on English pronunciation, who says 'we generally hear *Lunnon*.'

(e) *Loss of* -t- *before and after other consonants*

Wascote 'waistcoat' is found in a letter of Edward Alleyne the actor in 1593, and as *wascott* in that of one of the Verneys in 1639. The Verney Memoirs have also *Chrismas, Crismus, Coven Garden*; Lady Wentworth writes *Crismass, Wesminster, crisned, Shasbury* 'Shaftesbury.' Jones gives a long list of words in which *t* is omitted, including *Christmass, costly, ghostly, lastly, beastly, listless, mostly, roast beef, wristband, saltcellar, Wiltshire*, etc., etc.

(f) *Loss of final* -d

Numerous examples occur from the 14th century onwards. One of the Verneys has *friten* as a past participle. Cooper gives *thousn* as the pronunciation of *thousand*. Lady Wentworth writes *poun, thousen, dyomons, own* 'owned,' *scaffels*. Jones indicates that *-d* is not heard in *beyond, diamond, scaffold*, and many other words.

(g) *Loss of final* -t

The Verneys and their relatives write *respeck, gretis* 'greatest,' *Papeses, honis* 'honest,' *Mundy nex*, '*res* of our neighbours.'

Jones has a list of *t*-less words, including *respect, strict, sect, distinct*, etc. He also says that *pageant* is pronounced *pagin*.

Lady Wentworth writes *prospeck, richis* 'richest,' *tex*, and her son Peter, *strick* 'strict.' Baker, a writer on pronunciation (1725), writes *Egip, poscrip*, etc.

(h) *Addition of* y- *initially before* e

Yearth is the regular spelling in Edward VI's First Prayer Book (1549), and this and other forms of the kind are not infrequent in the 16th century even in literary works. The Verneys write *yearnestly* 'earnestly,' *yeare* 'ear' (a pronunciation which I have often heard from old-fashioned speakers whose English was irreproachable). Cooper indicates *yerb* and *yearth* with disapproval, and Lord Chesterfield gives the latter as a vulgarism in his day.

(i) *Addition of* d *and* t *finally after* n, l, s, *etc.*

Spellings such as *jaylardes, to past away, lynand* 'linen,' *wyld* 'will,' *synst* 'since,' and so on are fairly frequent in writings of various kinds, from the 15th century onwards. *Orphant* is frequent in the 16th century. The pronunciations which these spellings represent appear to have been common among educated speakers late into the 18th century. We may note that *vilde* 'vile' is a frequent spelling in Shakespeare (First Fol.), and that Donne rhymes *vilde* and *child*. The Verneys and their friends write *schollards* (Sir Ralph himself), *micklemust* 'Michaelmas,' *the hold yeare* 'whole,' *gownd* 'gown'; Swift rhymes *ferment*—*vermin*. Peter Wentworth writes, 'made the house *laught*,' 'not *saft* (safe) for me,' *sarment* 'sermon' (as does Lady Wentworth), *liked* 'like.' Lady Wentworth writes *gownds*, and her daughter-in-law Lady Strafford '*lost* of time.' Elphinstone, however, considers *sermont, drownd* (Inf.), *gownd, scollard, wonst* 'once' as vulgarisms, and Pegge (1814) records as vulgarisms typical of London, *verment* 'vermin,' *serment* 'sermon,' *nyst* 'nice,' and *margent*. It is clear that such pronunciations were in use among persons who were by no means vulgar fifty or sixty years earlier. *Margent*, strange to say, instead of *margin* survives as a poetical form and is used by Tennyson.

(j) d *for* t *and* b *for* p *between vowels*

Such pronunciations as *prodestant, Jubiter* may still be heard at the present time, and they would hardly be considered vulgarisms. There are plenty of examples of spellings indicating similar pronunciations during the 15th and 16th centuries. They evidently existed also in the period we are considering. Sir R. Verney writes *debutye*, and other writers in the Verney Memoirs have *prodistants, medigate* (mitigate), *Debity*. Jones says that as *b* is 'easier and sweeter' than *p*, the latter often 'takes the sound of *b*.' He indicates that *b* is pronounced in *capable, culpable, deputy, Gospel, Jupiter*, etc. Lady Wentworth writes *prodistant* and Lady Strafford *prodistation*. Elphinstone considers *proddestant* and *pardner* as London vulgarisms.

2. VOWELS IN UNACCENTED SYLLABLES

I pass now to consider the pronunciation of vowels in unaccented syllables. This question has been much canvassed of late, and it has been maintained that English has been degraded and impoverished by the universal habit among us of obscuring vowels in an unaccented position, and altering them from what is said to be the true sound, namely, that which they would have if they were fully accented. This view may be the right one—who shall decide the question?—but in any case the process of obscuring unaccented vowels is not a new one, and our generation is not responsible.

Already in the 14th century, and still more in the 15th, the frequent spellings prove that vowels when unaccented were *not* pronounced as if they were accented, but were altered, pretty much, apparently, as at the present time, only probably rather more consistently. For, while in most cases Englishmen at the present time who speak naturally and not according to theory, do alter their unaccented vowels, there are some words in which the full sound has been restored in deference to the spelling. Thus we often pronounce *fellow* with an '*o*-sound' in the second syllable instead of making the word rhyme with *prunella* as Pope did. Again, we pronounce an '*o*-sound' in *obey, obedience*, whereas in the 15th and 16th centuries these words are occasionally written *abay*, etc. These things have now become traditional, but they are modern for all that. We sometimes hear the second syllable of *fortune* pronounced like *tune*. This may or may not be a good thing to do, but, as we shall see, it is a modern innovation.

Out of the large mass of evidence regarding the treatment of unaccented vowels in the past, I can, for lack of space, only select a few examples. I begin with one of the most striking cases, where we have now often 'restored' the full vowel, though in some cases we still adhere to the old pronunciation. I refer to *u* in words borrowed from Norman-French.

We have the natural, traditional pronunciation of unaccented *u*, that is short *i* in *minute* (60 seconds), *biscuit*, and *conduit*, though as regards the last, although I have always heard it called '*kundit*,' I am told that it is now pronounced '*kondewit*' by some. I can only hope that this is not true.

The evidence for the earlier pronunciation of *-ur*, *-une*, *-u*(*i*)*t*, and final *-u* shall be stated rather more fully than for the points hitherto dealt with. It will be seen that this vowel in unaccented syllables is written *i* or *e*.

15th Century

- *-ur*(*e*) : *to paster, moister* 'moisture,' *venter* 'venture.'
- *-ut* : *savecondyte, condytte, byskitt, mynite* (a note).
- *-u-* : repetation 'reputation'

16th Century

- *-ur* : unscripterlye (Bishop Latimer), *jointer* 'jointure' (Earl of Bath, and Roper's *Life of More*), 'mannering the ground' (Wilson's *Arte of Rhetorique*), where it is evident that the word was accented on the first syllable, as it still is in provincial dialects.
- *-un* : *comyne* 'to commune,' mysseforten.
- *-u+ous* : *verteous, sumptious, tortious* 'tortuous (Spenser).
- *-u* : *nevys* 'nephews,' *moniment* 'monument' (Spenser).

17th Century

-ure : Verney Memoirs : [illegible] *futir, futer* 'future.' Cooper (1685) says that *picture* is pronounced like *pick't her.*

-une : Verneys have *fortin* 'fortune,' *fourtin, fortine, misfortin, unfortinate.*

-u- : Verneys : *miracilous, continial.*

-u : *valy* vb. 'value' (Lady Sussex), *neuie* (Mrs. Basire).

18th Century

-une : *fortin* (said by Tony Lumpkin in *She Stoops to Conquer*).

-ure : Wentworth Papers : *creators, torter* 'torture,' etc. Jones (1701) says *-ure* is 'sounded like *-er*' in *adventure, cincture*, etc.

-u- : Lady Wentworth has *vertious, vallyed* 'valued,' *yousyal* 'usual.'

What would be thought of one who nowadays should speak of 'leavin a *fortin* to his nevy'? And yet that was the manner of speech of scholars as well as of great ladies in the politest periods of our history.

The ending -on

The habit of pronouncing unaccented *-on* as *-in* (written *-in, -yn*, or *-en*) is traceable during the 15th, and the *-en, -in* spellings become increasingly common in the following centuries. Some words such as *pidgeon* are still commonly pronounced with *-in*, and old people alive till quite recently, pronounced *surgeon, luncheon, cushion* in this way.

Sesyn 'season,' *Devynshyre, reken* 'reckon,' etc., are found in the 15th century, and *reasyn* 'reason,' *burgine* 'to bud,' *mutten, Marten* College (Merton), *conmyshin* 'commission,' *dungen, to reckin, prysyn* 'prison,' *posshene* 'portion' in the 16th. The Verney Memoirs have *surgin* 'surgeon,' *ribins* 'ribbons,' *fashing* 'fashion.' In the 18th century Jones indicates what is certainly the same pronunciation, which he calls 'the sound of *e*,' in *contagion, cushion, fashion, luncheon, truncheon.* Peter Wentworth writes *beckinged*, Lady Wentworth *Compten*; Baker (1724) writes *sturgin, dungin* 'dungeon,' *punchin* 'puncheon,' *flaggin* 'flagon,' *cooshin.*

-ac- *in unaccented syllables*

15th Century

stomechere, almyneke.

17th Century

Verney Memoirs : *stomichers, obsticle, carictor.*

18th Century

Baker (1724) : *stomick, Isic.*

-a- *in unaccented syllables before various consonants*

15th Century

-ave : Seynt *Oleffes* (Olave).

-age- (-enge-) : *messynger*, etc. (very frequent).

16th Century

-ase : *purchisse* (Gabriel Harvey).

-an- : *compeny.*

17th Century

-an- : *compiny* (Lady Sussex).

-as- : Sir *Tomis* Chike (Lady Sussex).

-a- : *contrydicting.*

18th Century

-ave : *St. Olive* (Jones, 1701).

-ate : *pryvit* (Lady Wentworth) ; *chockolet* (Lady Strafford).

-o-, -ow-, *in unaccented syllables*

15th Century

dysabey ; *abedyensses* ; *sa mych* 'so much' ; *bysshape.*

16th Century

men a warre 'men-of-war' (Lord Berners) ; *Justus a pesse* ; *seaven a clocke* ; *ten a clocke* ; *apinions.*

17th Century

soriful (Lady Sussex) ; *acomidasyon* (ibid.) ; *abay* (Mrs. Basire) ; *fagets* 'faggots' (Lady Hobart); *Pigit* 'Piggott' (Lady Gardiner).

The examples are enough to show that in earlier times good speakers altered the vowel sounds in unaccented syllables pretty much as we do to-day, and that in some cases they went a good deal further than we do.

We see that the older pronunciation is that which makes a difference in unaccented syllables, and not that which attempts to produce a full vowel sound as it would occur in an accented syllable.

At the present time, the gospel of unchanged vowels in unaccented syllables is preached in some quarters. It is certainly a matter of taste whether English has a nobler and more beautiful sound when pronounced in a manner which is different from traditional habit and natural tendency. No one can complain if some people hold that it is so. But those who deliberately introduce this form of artificiality into their speech should frankly declare that they do this because they like it, and should not attempt to justify the practice by pretending that they are 'restoring' the primitive character of the language. It must be admitted that such so-called 'restorations' are, to use Dr. Johnson's phrase, 'capricious innovations,' which would have appeared as ludicrous in the successive ages of Caxton, Shakespeare, Dryden, and Pope as, to many, they appear to-day; indeed, they would have been even less tolerable then, because less familiar; the movement for 'reform' had not begun, so far as our evidence goes. If it existed at all, it must have apparently been confined to a small number of pedants and cranks whose influence was *nil*.

The general lesson we learn from a careful study of the English of the past is that standards of propriety in speech are for ever shifting, that there is no *absolute* 'right' and 'wrong,' and that many dogmatic statements on this subject have no sounder authority than belongs to individual whim.

(*Concluded.*)

Reviews of Books

The Control of Life. By J. ARTHUR THOMSON, M.A., LL.D. (Andrew Melrose, 7*s.* 6*d.*)

The purpose of this book is to vindicate a particularly modern thesis, namely, that Science is for life. It is written in an attractive way by one who is not only a professional biologist, but an acknowledged master of popular exposition. On the subject of science and life several books have appeared of late; this one differs from them in dealing with the subject mainly from a biological point of view.

From the informality of its diction, its occasional moralising, a repetition or two, and the nature of the few slips that have been made, it is not hard to gather that some of it at least is the spoken word, and one need not be a Sherlock Holmes to deduce further that the audience addressed consisted of men engaged in religious, educational, or social work, not specially trained in science, but evidently with wide interests, up against some of the problems of life and anxious to know what biological science has to contribute to their solution. These sentences may serve to give a general idea of the book and of the class of readers to whom primarily it should appeal.

Science is for life. Professor Thomson does not wish to argue that life is the only end of science, or that science and more science are the only things man needs in life. His point—and it is an old point, but a fresh and up-to-date exposition of it is both necessary and interesting—is that mankind may reach a new freedom and attain to greater heights by bringing more brains, as well as more good-will, to bear on the relief of his estate and the enlargement of everyday life; that an application of science to *every* practical problem will rid him of many hindrances that slow his progress towards the fuller realisation of his ideals.

Is there a single practical branch of human thought or knowledge that has been left untouched by the progress of science? Many would prefer to avoid answering this question, but the answer "No" must be given. It cannot be avoided. The physical conditions which control our existence must necessarily be more fundamental than the æsthetic, the moral, or the intellectual. Our religion, philosophy, and political systems must be in harmony and alliance with our science if they are to be a help and a happiness to man in his ascent.

The book is expository. Professor Thomson gives some examples of discoveries in the inorganic world that have given civilised people control over their environment: the X-rays which locate the pearl in the unopened oyster or the bullet buried in the bone; the ether which carries messages so that man from afar hears the cry of ships in distress upon the sea; the falls at Niagara which drive mills and illumine cities hundreds of miles away; the fertilisers made partly out of thin air; the preventive measures adopted in the conquest of plague and pestilence.

In the realm of organisms Professor Thomson cites the following examples: "The science of heredity has supplied levers which can be used with great practical effect in regard to cereals, root-crops, and fruits, cattle, sheep, and poultry. To the interesting problems of forestry, which are of great importance from the occupational as well as from the economic side, the methods of genetics and bionomics have only begun to be applied. It has been shown how 'waste places' like sandy heaths, pit-heads, and salt marshes, may be made profitable. . . . It may be that some discovery in bio-chemistry will change the whole economic problem of food-supply."

In a further chapter the author proceeds to illustrate other aspects of the rapidly growing biological control of life. He mentions the conquest of many microbic or parasitic diseases such as malaria; the development of serum therapeutics, which is so important in connection with diphtheria and tetanus; and the utilisation of the secretions of the ductless glands of other organisms to supplement deficiencies in our own.

The four subsequent chapters discuss the way in which biological science can help in questions of heredity, health, and nurture, and deal in some detail with such subjects as our natural inheritance, recent advances in the study of heredity, nature, and nurture, individually acquired modifications and their transmissibility, the biology of health and the individual life-cycle. The treatment of these subjects is exceedingly good considering the author's limits of space. A man who expects a stop-press *Encyclopædia Britannica* within the covers of a book of 275 pages will complain of scrappiness of treatment, but the sensible reader will see that each chapter is a useful introduction to a subject which may be pursued further in the larger treatises where the rate of exposition is less breathless.

Professor Thomson next deals with problems of population and social ideals, such as eugenics and eutopias, from a biological point of view. On these subjects he writes optimistically, (he believes in the idea of progress), but very wisely he realises and declares that, although the biological teaching is the first word on them, it is not by any means the last. He does not advocate, for example, killing off the unfit, or practising the ruthless methods of those who like to regard men as brutes.

"Our kindly social sentiment and sense of solidarity is a sign of progress; every right-minded person hopes for more. And yet we help the sickly, the diseased, the thriftless, the feckless, and we must go on helping them. . . . We have thrown off the yoke of Natural Selection. And yet, if we persist in sheltering inferiority from the penalties of inferiority, if we persist in not allowing supe- [illegible] we are assuredly making for trouble. So some brave men would return to Lycurgan methods, to Plato's purgation of the State. But we cannot do this wisely, we have not knowledge enough; and we would not if we could. . . . We must judge physical operations not only in themselves, but in the light of biological ideals, and biological operations in the light of the psychological, and psychological changes in the light of the social, which includes the ethical."

Readers who like this book might read along with it other books on the bearing of material progress upon life. Among such are Sir Richard Gregory's *Discovery* (Macmillan), Professor Soddy's *Science and Life* (John Murray), and *Science and the Nation*, published by the Cambridge University Press.

The Tale of Terror: A Study of the Gothic Romance. By EDITH BIRKHEAD, M.A. (Constable & Co., Ltd., 15s.)

The emotion of fear is based on one of man's primary instincts, that of self-preservation. It is little wonder, then, that from the earliest known days of their art storytellers have concentrated their efforts on exciting this emotion in their audience, and there are few novels written to-day which do not somewhere or other in their pages inspire us with suspense or fear in order to add zest and colour to their plots. But it is a rare fashion in storytelling when the whole of the plot is subordinated to arousing fear, and every other emotion is used merely to obtain this single result. Such a fashion came into full swing in the second half of the eighteenth century, and it is with this fashion that Miss Birkhead deals in the most exhaustive and scholarly treatise yet devoted to the subject.

The great mass of literature which this fashion brought to birth is now dead. Had it not ceased in later years to produce those "sensations of terror" so dear to the hearts of eighteenth-century readers, there might have been a chance for its continued existence as a classic literature of decadence. Its only interest to the mind of the twentieth century lies in its psychological significance, and we feel that this has not been sufficiently examined by Miss Birkhead. It is very noticeable that, as the first impulse of the Renaissance in England began to lose power, a greater earnestness, gradually deepening into gloom, took the place of the gaiety and *joie de vivre* that had flooded life and thought in the fifteenth and early sixteenth centuries. The earliest important literary echoes of this are to be found in Marlowe's tragedies and Shakespeare's tragedies and sonnets; depression deepens and terror increases in the drama of Webster, Beaumont and Fletcher, and Tourneur; the strengthened Puritanism of the Commonwealth becomes reflected in the cold, gloomy religiousness of Milton, and it survives the Restoration in the uncertain introspective poetry of John Donne and other writers. Eighteenth-century thought and literature, with its materialism, its common sense, and its dry wit, is a reaction to all this; but it is only a superficial reaction, and we can detect beneath it, in such phenomena as the "truly horrid novel" and its popular reception, the irresistible tendencies which were affecting and shaping our national mentality. The very fact that so many of these novels cultivate a supernatural terror seems to us to be an unconscious protest against the unspirituality of the age, to be an attempt to fill its place, as it were; while their romantic qualities cry out against its prosaicness. Moreover, in the dearth of adventure and war during the eighteenth century, the novel of terror created the needed diversion from humdrum contentment, and it had time to develop the impossibilities of its far-fetched romanticism before the nineteenth century arrived, with the rise of science and a popular mentality whose tastes were for a more realistic crystallisation of life in literature.

One of the most peculiar "signs of the times" was the cultivation of the mood of "melancholy." This has, we feel, never been sufficiently examined in connection with the Gothic romance and novel of terror, many of whose writers tell us in their prefaces that they wish to inspire us with feelings of "melancholy." Our belief is that it was a concomitant of the increasing earnestness and introspection, which we have mentioned, that began to appear in the late fifteenth century, and that its main origins lie in Burton's *Anatomy of Melancholy* (1621) and in Milton's *Il Penseroso* (1632). From then onwards we find increasing references amongst writers to the word which appears to have been descriptive of a mood of depression, usually experienced in loneliness—a somewhat artificially created "sweet sadness." By the middle of the eighteenth century nearly every poetaster tried his hand at an ode to Melancholy, or at verses which were designed to produce the effect of it. This is how Dr. Johnson's friend, Elizabeth Carter, apostrophises it:

> "Come, Melancholy, silent pow'r,
> Companion of my lonely hour,
> To sober thought confin'd!
> Thou sweetly sad ideal guest,
> In all thy soothing charms confest,
> Indulge my pensive mind."

Ogilvie addresses it in very similar notes, the poet Gray refers to it as a "pleasant sadness" in one of his letters, and his famous *Elegy in a Country Churchyard* (1750) is a typical though outstandingly good example of the *pathetic* and *sentimental* poetry of the later eighteenth century, other fairly well-known types of which may be found in Young's *Night Thoughts*, Blair's elegies, Bowles' *Sonnets*, certain of Burns' poems, and even as late as in the youthful Shelley's productions. Churchyards, rotting corpses, yew trees, the weirdness and solitude of moonlit wastes, are the invariable stage-scenery of these poems, which all aim at producing the sensation of *melancholy*.

The aims of the novelists of *terror* were generally identical with those of the *pathetic* poets. The methods of the novelists were various, and Miss Birkhead has been careful to distinguish the different schools. The earliest was that of the Gothic romance started by Horace Walpole in *The Castle of Otranto*, whose far-fetched supernaturalism makes monotonous reading. Mrs. Radcliffe, chiefly known nowadays as the authoress of *The Romance of the Forest*, created the " novel of suspense," and showed a marked ability for descriptions of romantic scenery and for puzzling the reader as to the development of her plots. She gives the reader the impression of the existence of supernatural agencies in the background, but, somewhat to his disappointment, explains them away at the end of her tales as merely material agencies. Terror was brought to a much higher pitch in the novels of Lewis and Maturin. Both wrote conscious melodrama and never spared a scrap of gruesome detail, and both owe much to Continental, particularly German, literature; but *The Monk* and *Melmoth the Wanderer* move vividly and powerfully to their tragic ends, and never cease to hold the reader's interest. The Oriental tales of terror, whose vogue was started by Beckford's *Vathek*, and the Rosicrucian novel started by Godwin and dying a natural death in Shelley's youthful and hysterical romances, gave place to the new fashion set by Sir Walter Scott in *Thomas the Rhymer* and *The Lord of Ennerdale*.

Since the days of Scott, the tale of terror, though it has long ago ceased to be the fashionable *rage*, has been widely developed. In America Hawthorne and Poe confined themselves chiefly to the *supernatural* tale of terror. A vast number of writers in England contemporary to them produced tales of material as well as of supernatural terror. Amongst later novelists the pastmaster of terror is Stevenson, whose *Dr. Jekyll and Mr. Hyde* may be considered as ushering in the psychological novel and indicating its even greater terrorising possibilities than the supernatural one; Joseph Conrad has done some remarkable work on somewhat similar lines, while Hugh Walpole possesses a weird capacity of allowing a suspicion of supernaturalism to hover in the background of his romances.

A bibliography would have added value to Miss Birkhead's book, but the footnotes supply a wealth of references to the bye-ways of eighteenth-century literature.

E. L.

A Philosopher with Nature. By BENJAMIN KIDD. (Methuen & Co., Ltd., 6*s.*)

Those who have read *Social Evolution* and *The Science of Power* will always remember Benjamin Kidd as a man who brought the mind of a poet as well as that of a scientist to the study of sociology. He possessed the faculty of opening up vistas of new meaning behind the hard facts of everyday political and international life. To him all the world was a stage, and he portrayed its past, contemporary, and possible future evolution with a dramatic suggestiveness. Whether we agree or disagree with the ideas that he read into international history, we who have read his work will be grateful to his genius for stimulating the mind to fresh trains of thought on social and international tendencies.

In this book of collected studies we see a quieter side of his mind—that of a natural historian living and delighting in the animal life of the countryside. But here again we find the creative artist creeping into the rôle of the accurate scientific observer. In describing wild life in the Severn estuary, Kidd suggests a possible explanation of the southward migration of birds " before the food-supply fails them, and before they have any physical want known to us indicating a coming change in the conditions of life." He puts this down to " the deep emotional effect on all wild nature of the waning light in the declining year, and the uncontrollable instinct to follow the sinking sun begotten in those whose habits of life it affects "; and he goes on to show how " deep down in the psychology of peoples lies the corresponding primordial instinct of the waning day." He indicates the fact that dying men have begged to have their faces raised to the setting sun, that many of our houses are built to face the west and our great European cities have grown towards it, till the " west-end " has in most cases become the residence of fashion, and how the " emotional, adventurous, sanguine " races have trended westward till they have conquered the ocean and followed the sun " over the virgin continent of the New World."

In utterances such as this we have the key to the spirit that dominates this great little book. It is an undogmatic, questioning spirit, probing suggestively into questions of science and natural history which have yet to be solved. In particular it concerns itself with the problem of how far it is instinct and how far mental process that governs the actions of the animal kingdom. Since the time of Darwin a vast amount of literature has been devoted to this subject. But no scientist or philosopher has surrounded it with so beautiful and quiet a setting as one can find in these short essays—a setting in which wild bees drone, moor-hens skim across deserted waters, and the nightingale sings from the shadows of great trees; into which the shot of a gun or the clank of a railway train penetrate only to fade away again quickly and to remind us symbolically that man's civilisation is ephemeral and that " it is the things of nature alone which are eternal."

E. L.

Karma, and other Stories and Essays. By LAFCADIO HEARN. (George Harrap & Co., Ltd., 5*s.*)

These posthumously collected and republished stories and papers of the late Professor in English Literature at Tokyo University make rather disappointing reading, and they hardly do justice to his personality. A consciously adopted poetical prose, which is the medium that this well-known American literary critic has used in the two longest tales in this volume, " Karma " and " A Ghost," is an insidiously dangerous form of literary expression. The great Russian novelist Turgenev tried his hand at it, and, though we cannot say that he entirely failed, we can say quite certainly that the tales of this type which he wrote are not comparable with his other work; De Quincey came near to success in this direction in *The English Mail Coach*; Walt Whitman's *vers libre* attains to great heights of beauty, but often falls into bathos and bizarrerie; the effect of that modern mystic Rabindranath Tagore's poetical prose is frequently quite lost in a plethora of words. The fact is that the essence of poetical expression is the quality of *suggestiveness*, while the essence of prose expression is the quality of *directness*. The combination of these two qualities is almost impossible, and the best writers sooner or later find themselves out of their depth in trying to maintain it. Artificiality sets in after the first few paragraphs, and personality is lost. It is for this reason that we fail to detect Hearn's personality in these tales. That is why they are not literature of the first water, for in great fiction we are invariably shown life through the medium of the writer's own personality.

In *Karma* we encounter the problem of whether a man should give the woman of his heart a full, written confession of the faults in his past life. However great the emotion that impels a writer to tell the story that centres round such a problem, it will never be fully conveyed to the reader unless his sympathy with the hero of the story is maintained. Our sympathy with the hero of *Karma* is not maintained, because his character and his emotions are enveloped in a mass of words. As for the angel of his dream, she is a sentimental prig who, a year after sending the man away from her as the result of reading his confession, suddenly arrives in the city of his exile and informs him that she will help him to bear his suffering, most of which seems to us to have been brought about by herself.

If de Maupassant had written on such a subject, he would have developed the priggishness of the woman's character with a conscious irony, and he would have ended by making the man turn the tables against her in refusing to have anything to do with her when she eventually turned up again to claim him. If Tchehov had treated it, he would have shown two human beings played upon by emotions too strong and subtle for them, and he would have ended on a note of pity for both of them, still wavering as to the future courses of their lives. Both writers would have dismissed the plot in a quarter of the space used by Hearn, and both would have inspired us with feelings of sympathy or pity for one or both of the characters.

I have purposely judged Hearn by high standards because there exists a considerable element of greatness in his somewhat uneven productions. He can touch a responsive chord in our hearts by the perfect expression of feelings that have come to so many of us. *A Ghost* is full of such human echoes, of which this passage is an example : " Oh ! the first vague charm, the first sunny illusion of some fair city—when vistas of unknown streets all seem leading to the realisation of a hope you dare not even whisper ; when even the shadows look beautiful, and strange façades appear to smile good omens through light of gold ! And those first winning relations with men, while you are still a stranger, and only the better and the brighter side of their nature is turned to you ! . . . All is yet a delightful, luminous indefiniteness —sensation of streets and of men—like some beautifully tinted photograph slightly out of focus. . . ."

Of the papers in this volume " The First Muezzin " contains an account well wrought from many sources of the origin of the Moslem Call to Prayer, and a prophetic note dominates the essay on " China and the Western World," which originally appeared in *The Atlantic Monthly* as far back as 1896. Both papers are written in clear and forceful prose.

E. L.

The Electric Furnace. By J. N. Pring, M.B.E., D.Sc. (Longmans, 32s.)

How amazingly large and detailed science has become in the last fifty years ! Physics is but a very small branch of science, and electricity of physics, and here is a book of five hundred pages on the electric furnace, a small branch of electricity. The electric furnace, just that. And five hundred pages of close print with diagrams, photographs, index and the whole make-up of the modern scientific handbook. What amazing people these scientific authors must be ! How do they manage it ? Do they themselves know everything in the books they write ? What excellent memories they must have !

This book is the latest volume of the series of monographs on industrial chemistry that are being edited by Sir Edward Thorpe. It is a general technical discussion of the position and prospects of high-temperature industrial chemistry. The author has many qualifications for writing this book. For years he has been engaged in research in electro-chemistry, he has read widely, he has visited many of the chief electro-chemical centres of Europe and America, and he has a good eye for the economics of a commercial undertaking. Also, like many of the scientific book-writers of late, he has had an exceedingly valuable war experience with the Ministry of Munitions. The book is written for technical readers only. Such like the information to be fresh, up-to-date, relevant and as accurate as possible. This book, therefore, I judge, will be useful to them and is well worthy of its inclusion in Sir Edward Thorpe's series.

The electric furnace is connected in the minds of most of us with the name of Moissan and the production of artificial diamonds. We have not heard so much about these diamonds of late, and without doubt they are not yet sufficiently numerous and large to disturb the pleasant connection existing at present between Kimberley, Park Lane, and the general public. In this book their real place in the category of useful things is sufficiently indicated by their not being mentioned at all. No, the electric furnace's real value is in making less spectacular things like steel, carbides, and nitric acid.

The electric current has been used in manufacturing processes in two ways. There is its chemical or electrolytic action, which is the principle on which the large-scale manufacture of such metals as aluminium and sodium, and the refining of metals like zinc and copper, depend.

Secondly, simply as a producer of heat it has led to the attainment of temperatures higher than those attained by other methods, and this has naturally opened up an important field of chemistry and, as it has happened, of industrial chemistry, for many of the products isolated for the first time in the electric furnace, like artificial graphite, the carbides, and the highly refractory metals in a compact form, have received an important commercial application. Again, in spite of the cost, there is a progressive tendency for the extension of electrical methods of heating to chemical processes at all ranges of temperature. In the manufacture of certain classes of steel, of iron and of iron alloys, the electric furnace is supplementing, and in some cases supplanting, the older "flame" furnace. "Electric" heat can always be more conveniently applied and controlled. It can raise the material being treated to higher temperatures and keep it freer from contamination by gases, etc., than the heat generated in the usual way, and for high-grade steels, where quality is of the first importance, the electric furnace seems to have a field of its own. Other notable substances manufactured in the electric furnace are calcium carbide, carborundum and the important compounds of nitrogen, ammonia and nitric acid, made from the atmosphere, which are the bases of many fertilisers and of all modern explosives.

Dr. Pring puts the whole matter before his readers. In addition to a description of the great manufacturing processes in which electric furnaces are used, he deals with such diverse subjects as current supply, transformers, the measurement of high temperatures, heat losses through furnace walls, water-power development, and even the design of furnace terminals. The illustrations, diagrams, and tables, with which the book is plentifully supplied, all help to make the book more valuable. Alas, also, they make its price high. Is one a churl to expect a good book and then to object to its price? A publisher, there can be no doubt, knows much more about cost of production than a reviewer; he must also know, from the results of the sales of other books, how many people can afford to pay the apparently high price for them, so fixing the price is clearly his business. Yet thirty-two shillings is a lot of money whatever it be spent upon. A monograph is a book to be bought, not merely to be consulted, and a high price prevents its purchase by many readers who happen not to be made of money. The majority of scientific textbooks still follow in the old rut of dry explanation of elementary matter, "page one stuff," in which no one, not excepting the author, takes the least interest. This book contains much matter likely to be found in books intending readers already possess. The omission of this would make the book less comprehensive, less complete, but not in the least less valuable, and might have made it possible for the publisher to lower its cost a little, perhaps even to the humble sovereign.

A. S. R.

Books Received

(Books mentioned in this column may or may not be reviewed in this number, or in a later number.)

ARCHÆOLOGY

Balabish: The 37th Memoir of the Egypt Exploration Society. By G. A. WAINWRIGHT. (George Allen & Unwin, 42*s.*)

LITERARY CRITICISM

Modern English Drama: An Outline. By PATRICK KIRWAN. (National Home-Reading Union, 1*s.*)

MISCELLANEOUS

The Fellowship of Learning. Presidential Address delivered by SIR F. G. KENYON, K.C.B., at the Annual General Meeting of the British Academy, July 6, 1921. (Published for the British Academy by Humphrey Milford, Oxford University Press, 1*s.* 6*d.*)

Travels of a Consular Officer in North-West China. By ERIC TEICHMANN, C.I.E. (Cambridge University Press, 25*s.*)

The Wit of the Wild. By ERNEST INGERSOLL. (George Routledge & Sons, Ltd., 6*s.*)

Fasting and Man's Correct Diet. By R. B. PEARSON. (Published by the Author, Chicago, U.S.A.)

PSYCHOLOGY

Seven Ages of Childhood. By ELLA LYMAN CABOT. (Kegan Paul, Trench, Trübner & Co., Ltd., 12*s.* 6*d.*)

The Care of the Adolescent Girl. By PHYLLIS BLANCHARD, Ph.D. With Prefaces by DR. MARY SCHARLIEB and PROF. G. STANLEY HALL. (Kegan Paul, Trench, Trübner & Co., Ltd., 7*s.* 6*d.*)

Taboo and Genetics, A Study of the Biological, Sociological and Psychological Foundations of the Family. By M. M. KNIGHT, Ph.D., IVER LOWTHER PETERS, Ph.D., and PHYLLIS BLANCHARD, Ph.D. (Kegan Paul, Trench, Trübner & Co., Ltd., 10*s.* 6*d.*)

SCIENCE

Terrestrial Magnetism. British (Terra Nova) Antarctic Expedition, 1910–1913. By CHARLES CHREE, M.A., Sc.D., LL.D., F.R.S. (Harrison & Sons, Ltd.)

What is Science? By NORMAN CAMPBELL, Sc.D., F.Inst.P. (Methuen & Co., Ltd., 5*s.*)

Early Science in Oxford. Part I, Chemistry. By R. T. GUNTHER. (Humphrey Milford, Oxford University Press, 10*s.* 6*d.*)

Relativity and the Universe. By DR. HARRY SCHMIDT. Authorised translation by KARL WICHMANN, M.A., Ph.D. (Methuen & Co., Ltd., 5*s.*)

The Mechanism of Life. By JAMES JOHNSTONE, D.Sc. (Edwin Arnold, 15*s.*)

The Origin and Evolution of the Human Race. By ALBERT CHURCHWARD, M.D. (George Allen & Unwin, 45*s.*)

The Advancement of Science, 1921. Addresses delivered at the 89th Annual Meeting of the British Association for the Advancement of Science, Edinburgh, September 1921. (John Murray, 6*s.*)

Aggregation and Flow of Solids. Being the records of an experimental study of the Micro-structure and Physical Properties of Solids in various states of Aggregation 1900–1921. By Sir George Beilby, F.R.S. (Macmillan & Co., Ltd., 20*s.*)

The Physical Properties of Colloidal Solutions. By E. F. Burton, B.A., Ph.D. (Longmans, Green & Co. Second Edition, 12*s.* 6*d.*)

Biological Chemistry. By Prof. H. E. Roaf, M.D., D.Sc., etc. (Methuen & Co., Ltd., 10*s.* 6*d.*)

Miscellanea

To the Editor of Discovery

Dear Sir,

In his letter to you last month Mr. Williams asked where the elements coronium and nebulium found in the sun figure in the list of chemical elements. The present arrangement of elements in the periodic system suggests that all light elements heavier than hydrogen have been discovered, and if nebulium and coronium prove to be genuine new elements, not lighter than hydrogen, then this arrangement is less perfect than it appears to be at present. Two things, however, should not be lost sight of: (1) as neither coronium nor nebulium are found on the earth, knowledge of them is scanty; and (2) one or both of these elements may be lighter than hydrogen or may be "isotopes" of hydrogen, helium, or some light element. If either of the alternatives of (2) proves correct, the difficulty Mr. Williams mentioned is removed. It may be mentioned that "isotopes" both of hydrogen and helium exist. Each has an atomic weight of three. They are, of course, distinctly different gases.

Oxford, A. S. Russell.
September 10, 1921.

* * * * *

In our September issue we referred to a note on the "Tudor-Hart Theory of Colour" that had appeared in the July *Psyche* (the new form of the *Psychic Research Quarterly*). It touched on ground where the account of "Revolutionary Movements in Modern Painting" in our August issue made a halt, and we quote a portion of it here for its interesting suggestiveness: "*The* analogy (*between Colour and Sound*), which has appealed to many students ever since the days of Newton, depends, first, on a precise standardisation of colour . . . and, second, on the correct correlation of the variables which determine sound and colour respectively. Each can vary in three ways: Sound in respect to Pitch, Loudness, and Quality, and Colour with regard to Luminosity (brightness), Saturation (purity), and Hue (colour, e.g. red, blue, green, yellow, etc.).

"Mr. Tudor-Hart finds, as a result of laborious researches extending over many years, that if these variables are once rightly related to one another (luminosity to pitch, saturation to loudness, and hue to quality), it is possible to transpose from musical harmony into colour harmony without change. That is to say, the colour analogue of a harmonious musical chord will also be harmonious and *vice versa*. Moreover, which is even more remarkable perhaps, the emotional effects produced by the colour analogue will be equivalent to those produced by the musical chord itself.

"This discovery, into the ramifications of which it is not possible to enter here, opens the way to a new treatment of colour problems. It makes possible the production of a standardised colour notation whereby all who are concerned with the handling of colour may refer unambiguously to just that hue, saturation, and luminosity which they have in mind. The value of such an advance for practical work can hardly be over-emphasised, for the colourist will at last be as favourably placed as the musician with regard to technique and the manipulation of his medium; and the vague, even when correct, intuitions of artists will be capable of fixation in determinate form, in the same fashion as are the inspirations of musical composers.

"This ideal may still be remote, but Mr. Tudor-Hart's work has unquestionably done more than that of any contemporary student to indicate how it may be attained."

* * * * *

A novelist of the Jack London type should find a wealth of "copy" at the small port of Tromsö, which lies on one of the northerly fiords of Norway. From a description of it that a member of the Oxford University Expedition to Spitsbergen, which has now returned to this country, gave us the other day, it resembles nothing so much as Dawson City during the days of the Klondyke goldrush. Tromsö nowadays acts as the base for nearly every "coal" venture in Spitsbergen. Speculators, mining engineers, explorers, and "hangers-on" of every European nationality jostle each other in its streets, Danes and Scotchmen are very prevalent, but most conspicuous are the inevitable Russian Jews. Some of the latter make hundreds of thousands of pounds over buying and selling coal claims, and appear to spend a weird nomadic existence between the wilds of Spitsbergen and the pleasures of Paris. Everyone is suspicious of everyone else and, for the whole of the short period that our friend spent there, he was pestered with questions by people who could not believe that he was proceeding to Spitsbergen merely for scientific research! Before the end of the year we hope to publish an illustrated summary of the work carried out by the expedition.

* * * * *

We regret that news of the Mount Everest Expedition sent recently to *The Times* by Col. Howard Bury, who is in command, is not hopeful. It has been found that an ascent from the northern or north-western side is not practicable, and the southern side seems equally hopeless because of the high precipices which flank it. The expedition has consequently moved its base to the eastern side, and pitched camp at a spot in the Arun valley 12,300 feet high. On August 2 the exploration of the eastern approaches was begun, but, as the last news was dispatched two days later, it is not yet known with what success. Nine thousand miles of new country have already been mapped by the party.

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Editorial Notes

NOT many weeks ago we witnessed a strange phenomenon in British mentality and psychology. During the meetings of the British Association, in which momentous discoveries in every branch of natural and applied science were being revealed and discussed by our most eminent scientists, a well-known film "star" arrived in England. We need not dwell on the many details of his popular triumph at the hands of both public and Press, to show how great and spontaneous it was—far greater and more spontaneous, for instance, than the interest accorded to the members or the discussions of the British Association. Now it serves no purpose to wail over such a phenomenon as though it were a proof of national decadence. We need to look at the facts clearly and calmly. The facts are that Charlie Chaplin is in his own sphere a genius; that the average man and woman need something not too serious to enliven their leisure hours, and that one of the easiest channels to such enlivenment lies through the moving picture; that cinemas have spread to the smallest town and to the remotest corners of the world, and are therefore able to bestow a world-wide fame on cinema "stars" such as no scientist, philosopher, or writer can expect to attain to till long after he is dead.

* * * * *

But these are only some of the facts, and, making all allowances for their importance, we feel that they do not explain the phenomenon to our satisfaction. For the phenomenon grows out of some deeper tendency, such as has recently produced the strange eclipse of interest in any other current topic by the attention paid to the Carpentier-Dempsey boxing-match, such as every day turns the gaze of the average man to the "sports" page rather than to the more serious news in his daily paper, such as would, in the event of their death on the same day, induce our Press to publish far longer biographies of Charlie Chaplin than, say, of so distinguished a scientist as Sir Edward Thorpe. If we had space we could put forward a hundred and one reasons for these phenomena, but we believe that the chief reason lies in the peculiar social evolution of our times.

* * * * *

It is easy enough to look back to past centuries and sigh for the active pursuit of knowledge that characterised the reigns, say, of Elizabeth or Victoria. But that pursuit was confined to a small, leisured class living, in the days of Elizabeth, amongst a multitude of semi-barbarians, and, in the days of Victoria, amongst a population that was only beginning to learn the rudiments of reading and writing. As we pointed out in our editorial notes several months ago, "the spirit of our own age is affecting all grades of our social complex." So far as the public to whom intellectual workers are to appeal is concerned, democracy produces a process of levelling up *and* levelling down the collective intelligence of a nation; a wider but more mediocre public. Now comes the question, "How is a powerful, living contact to be made and maintained between such a public and the advanced intellectual workers?" This question *must* be met in some practical attempt, for otherwise democracy will not promote, but obstruct progress; more than that, in the long run, without the stimulus that the sciences and arts supply to the social condition of the community, it will not produce a utopia, but a break-down in civilisation.

* * * * *

There is no doubt that our men of science are to-day more than ever cognisant of this danger. Such a realisation but a common tone to all the speeches at this year's meeting of the British Association. Particularly remarkable from this point of view was Sir Richard Gregory's address[1] to the delegates of corresponding societies, urging them to make the importance of science, as well as its material assistance, felt in every corner of the country. Amongst many other fine and apposite statements, Sir Richard said: "In mechanics work is not considered to be done until the point of application of the force is moved; and knowledge, like energy, is of no practical value unless it is dynamic. The scientific society which shuts itself up in a house where a favoured few can contemplate its intellectual riches is no better than a group of misers in its relations to the community around it. The time has come for a crusade which will plant the flag of scientific truth in a bold position in every province of the modern world. . . . It is not by discoveries alone, and the records of them in volumes rarely consulted, that science is advanced, but by the diffusion of knowledge and the direction of men's minds and actions through it. In these democratic days no one accepts, as a working social ideal, Aristotle's view of a small and highly cultivated aristocracy pursuing the arts and sciences in secluded groves and maintained by manual workers excluded from citizenship!"

* * * * *

It is true that in the past the intellectual worker has not sufficiently exerted himself in order to grip the attention of the public; it is equally true that the public has not hitherto manifested interest in his work. In his Presidential Address[2] at this year's Annual General Meeting of the British Academy, Sir Frederick Kenyon particularly emphasised this apathy:

"The progress of knowledge," he said, "of education, of culture in the widest sense of the term, is hampered by the dead weight of indifference with which it has to contend. Taking the British public as a whole, there is a solid mass of disbelief in the value of knowledge and of the things of the mind. In spite of the large class of amateurs of culture that the country possesses, people who sympathise with things of beauty and learning without pretending to be professional students of them, the nation has no deep-rooted faith in the necessity for such things. We are predominantly a materially minded people. Consequently literature, art, knowledge, wherever they have not an obvious material value, have to fight everywhere for recognition."

* * * * *

So the fault is on both sides, or, rather, it is a fault resulting from the peculiar social conditions of our times. We shall not overcome it merely by education. An urge to a greater collective seriousness and care of thought must be started. The gulf of indifference must be bridged from both sides. On the one hand the intellectual workers will have to ford right out into the currents of daily life. Scientists have already done splendid service in this way, but, as Sir Frederick Kenyon pointed out later in his speech, they need to show a common front to the world; to show that their many branches of work link up one with the other; they need to show that the work of both natural and applied science is the backbone of nearly every commercial undertaking and every convenience of modern civilised life; that natural science, even when it has no immediate or apparent practical value, as, for instance, in Astronomy or Anthropology, opens up vistas of knowledge about ourselves and the universe in which we dwell, and makes us more sentient, more god-like beings. And our creative artists and scholars must continually be emphasising the fact that literature, art, and music are not composed just to worry schoolboys, to fill up the shelves of libraries, and to provide serious entertainments in the concert-hall or picture-gallery, but that they are forged from the very experiences and emotions of life, and react with incalculable effect on international, national, and individual destinies. Popular expositions of all branches of knowledge by the experts themselves, local scientific and artistic societies, the opportunities offered by institutions like the Workers' Education Association and the Co-operative Education Union, clubs for all classes and of all types in which our pioneers of thought can reveal and discuss their discoveries with members in a friendly spirit, cheaper books, the right kind of co-operation by the Press—all these things are needed more than ever to-day.

* * * * *

And the public itself must meet the intellectual workers half-way and extend their sympathies to such movements. Politicians and business men can give them far more material support than they have hitherto done; our *leisured* and so-called *educated* classes must abandon their phlegmatic, half-contemptuous attitude to "learning"; the manual worker must be willing to realise that mental work is in its own way just as arduous and productive of results as his own work, and that the mental worker is a friend, not a foe. In Britain we are still apt to look askance at "stinks" men, "wild" poets, "book-worms," and "effeminate" musicians, and to forget that without them we should not have been blessed with electric light, telephones, railways, theatres, cinemas, and novels. But these are only some of their more concrete and visible contributions to life. In promoting knowledge the sciences and fine arts are at once the inspirers and measurers of mankind's progress. A civilisation, for instance, affects the later history of the world not nearly so much by its imperial power as by the progress that it makes in thought and mental ideals. The poetry of a David or a Dante; the teaching of Buddha or Socrates or Plato or Paul—to appeal to no other names—have been a much greater influence in the world than the generalship of Alexander the Great or Napoleon Buonaparte.

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[1] *The Advancement of Science*, 1921 (John Murray, 6s.), contains all the Presidential Addresses at this year's meeting.

[2] *The Fellowship of Learning*. By Sir F. G. Kenyon, K.C.B. (Published for the British Academy by Humphrey Milford, Oxford University Press, 1s. 6*d*.)

* * * * *

In conclusion, we emphasise the immediate need of spreading knowledge and culture and the desire for them throughout this country and this Empire. Behind all voluntary action, individual or concerted, lies thought; so much uninstructed thinking on every problem, social, political, scientific, is apparent nowadays, that the need for true knowledge and for the habit of seeking it humbly and patiently is imperative; without true knowledge there is wrong thought; with wrong thought there will be wrong action, and in national and international affairs, which are steadily becoming more complicated, disaster and chaos will most certainly ensue. True knowledge makes us understand ourselves and others; it will lend us sympathy and give durability and foresight to our individual, our social, and our political life. Four years after the Battle of Waterloo, when Europe was in much the same position as she is to-day, struggling to free herself from the aftermath of protracted wars, a great poet saw this need, and completed one of his lyrical plays [1] with these lines:

> "Gentleness, Virtue, Wisdom, and Endurance,
> These are the seals of that most firm assurance
> Which bars the pit over Destruction's strength;
> And if, with infirm hand, Eternity,
> Mother of many acts and hours, should free
> The serpent that would clasp her with his length;
> These are the spells by which to reassume
> An empire o'er the disentangled gloom.
>
> To suffer woes which Hope thinks infinite,
> To forgive wrongs darker than death or night;
> To defy Power, which seems omnipotent;
> To love, and bear; to hope till Hope creates
> From its own wreck the thing it contemplates;
> Neither to change, nor falter, nor repent;
> This, like thy glory, Titan, is to be
> Good, great and joyous, beautiful and free;
> This is alone Life, Joy, Empire, and Victory."

THE October number of *The Geographical Journal* contains, amongst other interesting features, some remarkable photographs of Mount Everest and its surroundings, taken by Lieut.-Col. Howard Bury, D.S.O., Chief of the Mount Everest Expedition. The *Bulletin* of the League of Red Cross Societies (published every two months at Geneva in English, French, Italian, and Spanish) is a sign of the developments that are occurring in international co-operation in the world of surgery and medicine. Amongst other articles in the July–August issue are descriptions of the famine in China, new aeroplane ambulances, and new methods of combating tuberculosis.

Dante's Lyrical Poems

By Edmund G. Gardner, Litt.D.

Professor of Italian Studies in the University of Manchester

ITALY has just celebrated the sixth centenary of the death of Dante, not only by solemn functions at Ravenna, Florence, and Rome, but also—in a more permanent fashion—by the publication, under the auspices of the Società Dantesca Italiana, of the first critical edition of the text of his complete works. A most noteworthy feature in this volume is the presentment of the *Rime* by Professor Michele Barbi, whose researches—which have occupied him for many years—have resulted, for the first time, in a clear discrimination between authentic, doubtful, and spurious compositions, and in a text which (if not in all respects absolutely decisive, for that, given the manuscript conditions under which they have come down to us, would have been an impossible achievement) is an immeasurable advance upon anything which we have hitherto possessed.

The *Rime*—sometimes, less accurately, known as the *Canzoniere*—is a collective title for Dante's lyrics, more particularly those which he did not insert in the *Vita Nuova* or which were written later. They include canzoni, ballate, and sonnets. Italians, of course, regard the last-named as a lyrical measure, and John Addington Symonds, it will perhaps be remembered, aptly described a sonnet as "essentially a meditative lyric." English readers probably made their first acquaintance with some of these poems in the selection translated by Rossetti in *Dante and his Circle*. Rossetti chose 3 canzoni (the sestina is only a special form of canzone), 1 ballata, and 11 sonnets. But those were uncritical days. Two of the canzoni, "Love, since it is thy will that I return" and "Death, since I find not one with whom to grieve," the ballata, "Because mine eyes can never have their fill," and two of the sonnets, "My curse be on the day when first I saw" and "The King by whose rich grace His servants be," are now known, beyond the shadow of a doubt, to be the work of other poets than Dante. Later, the standard of reference for the *Rime*, or *Canzoniere*, has been the section devoted to them in the *Oxford Dante*, based originally on Fraticelli, but unsatisfactory as to the text, including many spurious and excluding not a few unquestionably authentic poems. For English readers, the little volume edited by Dr. Wicksteed and Professor Okey in the *Temple Classics* marked a distinct advance in all these respects, but made no claim to be anything more than provisional. Professor Barbi's work now represents the fulfilment of one of the most urgent needs of all students of Dante.

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[1] Shelley, *Prometheus Unbound*.

Apart from the *Vita Nuova* and the three canzoni included in the *Convivio* (the unfinished work in which he intended to comment upon 14 of these poems), the critical edition accepts as genuine poems of Dante 13 canzoni, 5 ballate, 34 sonnets, and 2 stanze. It is pleasant to observe that two sonnets, translated by Rossetti, but unhesitatingly rejected by recent editors, are now given a place in the canon. These are the charming "Master Brunetto, this my little maid," which, however, has no connection (as Rossetti supposed) with Brunetto Latini or the *Vita Nuova*, and "Upon a day came sorrow into me," which Rossetti took as referring to the death of Beatrice. I must confess personally to being not quite convinced as to the sufficiency of the evidence for the unqualified acceptance of some of the poems received into the canon; but this is immaterial.

The *Rime* bring to perfection the technique of early Italian lyrical poetry, itself in part a heritage of the poets of the Sicilian school from the troubadours of Provence, and the spiritual ideals of the "sweet new style," of which the initial inspiration came from Guido Guinicelli at Bologna. They gradually prepare the way for the ampler music of the *Divina Commedia*.

Dante no doubt included what he regarded as the best of his lyrics for Beatrice in the *Vita Nuova*; but we find among his "juvenilia" such little masterpieces as the sonnet to Guido Cavalcanti, *Guido, i vorrei che tu e Lapo ed io*, with its romantic atmosphere and Merlin's enchanted boat, and that other, *Suonar bracchetti e cacciatori aizzare*, in which the poet of love appears incongruously at a hunting party and appreciates a kindly jape at his own expense:—

"Guido, I would that thou and Lapo and I were taken by enchantment and set in a boat, which under every wind should course the sea at your will and mine; so that no tempest or other evil weather could hinder us, but rather, living always in one desire, our wish to abide together might increase. And Lady Vanna and Lady Lagia too, with her who is thirtieth on the roll, should the good magician place with us; and there to discourse always on love; and each of them to be content, as I am sure that we should be.

"Beagles questing and huntsmen setting on, hares starting and folk hallooing, and from the leash swift hounds issuing to scour fair slopes and seize the quarry! In sooth, I think it should delight a heart that is free and void of purpose; and I, among my amorous musings, am mocked by one on this account, who jests with me thus in familiar wise: 'Now see the chivalry of a noble heart; for a sport so rustic to leave ladies and their joyous semblance!' Then, fearing lest Love may hear, I am ashamed, and go downcast thereat."

In a lighter mood, too, are some of the pieces which appear for the first time in the present edition; the sonnet on the Garisenda tower of Bologna; various epistolary sonnets, in which no doubt at times, when answering friends or other contemporary rhymers, Dante wrote without any very serious intent or deliberation: "Rispondo brieve con poco pensare," as he says in one of the sonnets now added to the list. In the abusive tenzone with Forese Donati (which should not, perhaps, be taken too seriously), Dante is following the practice, which Rustico di Filippo had made characteristically Florentine (though Guido Guinicelli himself once did the like), of employing the sonnet for satire and burlesque. Most of the sonnets interchanged with Cino da Pistoia belong to a later date, and—with one exception—are in a strain of high solemnity.

The most striking lyrics composed by Dante during the years between the completion of the *Vita Nuova* and his exile are the "rime pietrose" and certain allegorical poems expressing a novel conception of love. The former—four canzoni—are remarkable for a peculiar and incessant playing upon the word *pietra*, "stone," which led to the theory that they were inspired by a lady named Pietra, or, at least ("Pietra," like other names of this kind introduced into Dante's lyrics, being probably a device like that used by the Provençals), by one who had proved hard and rigid where Beatrice had been the giver of blessing. One of the group strikes a note of stormy, even sensual passion that we hardly meet elsewhere in Dante's lyrics. In another, "To the show day and the great circle of shadow" (familiar to English readers in Rossetti), we have the first example in Italian of what was later called a sestina—the peculiar form of canzone invented by the troubadour, Arnaut Daniel, for the expression of the mood of a mind haunted by fixed ideas round which it plays in a poetical attempt to discover their ultimate relations with itself and with each other. But the unquestionable masterpiece in this group is the canzone, "I am come to the point of the wheel," on love in winter, contrasting stanza by stanza the phenomena of the external world in the season of ice and snow with the state of the poet's soul, ever burning in the "sweet torment" of love's fires. It is the artistic perfecting of a species of poem not unfrequent with the troubadours of Provence.

The allegorical canzoni express a love that is identical with philosophical devotion. Dante writes in the *Convivio* (ii. 16): "By love, in this allegory, is always intended that study which is the application of the enamoured mind to that thing of which it is enamoured." They illustrate the fundamental idea of the *Convivio* that philosophy is the amorous use of wisdom, or, as Hugh of St. Victor put it, "the love and the study and, in a certain manner, the friendship of wisdom." The student's impassioned quest of philosophical truth, with its alternations of success and failure, is translated into the language of the earthly lover in his pursuit of a mortal mistress, and philosophy herself becomes an idealised human personality whose body is wisdom and whose soul is love. The supreme, triumphant expression of this suprasensible intellectual passion is found in the second canzone of the *Convivio:* "Love that in my mind discourses to me." (where the presentation of the lady of the poet's mystical creed is modelled upon the Beatrice of the *Vita Nuova*)[1]; the record of some hour in the student's labour when the clouds suddenly lift, height above height is revealed, and the path seems clear and easy to the aerial battlements of some spiritual fortress that before seemed inaccessible. I believe that the canzoni, "Love that movest thy power from heaven," and "I so feel the great might of love," together with several minor lyrics which Professor Barbi similarly classes as "rime d' amore," should be placed in the same series. A pendant to this group is given by the two didactic canzoni, in which Dante, when inspiration flags, turns from singing of philosophical love to some humbler ethical theme, "for the good of the world that liveth ill"; the canzoni on *gentilezza*, true nobility, and *leggiadria*, the outward manifestation of a chivalrous soul in man and its counterpart in woman.

Dante wrote few lyrics in exile, but two are among his greatest. The canzone, "Three ladies have come around my heart" (which fascinated Coleridge), has been called his poetical "apologia pro vita sua." From the legend of the apparition of Lady Poverty and her two companions to St. Francis, and the fifty-first chapter of Isaiah, it weaves an allegorical representation of how the call came to Dante to stand forth as the proclaimer of justice, *vir praedicans justitiam.* It is here that the poet declares that he holds his exile as an honour, and first utters the prophetical note which is to sound again in sterner accents in the *Divina Commedia.* Almost as powerful and impressive, though of less purely poetical value, is the canzone, "Grief brings courage to my heart," upon which, in the *De Vulgari Eloquentia*, Dante bases his claim to rank as the poet of "rectitudo." In its scathing satire of vice, its realism and psychological insight, this canzone, too, prepares us for the *Divina Commedia*; but it is on a lower spiritual plane than its predecessor. There is evidence that Dante intended to comment upon these two poems in the fourteenth and fifteenth treatises of the *Convivio*, if that work had been completed. It is strange enough, after these poems, to find Dante singing once more of earthly love, in a canzone of which the true significance in his inner life remains an impenetrable mystery. That I cannot follow Professor Barbi in closing the *Rime* with a love sonnet: *Per quella via che la bellezza corre*; "Along that way which beauty runs when she goes to waken love in the mind"; for this seems to me to belong unquestionably to a date before Dante's exile. Rather should I take as the epilogue to his lyrical work one of the sonnets to Cino da Pistoia:

> "Io mi credea del tutto esser partito
> da queste nostre rime, messer Cino,
> chè si conviene omai altro cammino
> a la mia nave più lungi dal lito."

"I deemed myself utterly departed from these rhymes of ours, Messer Cino, for henceforth another track befits my ship more distant from the shore." Dante's lyrical work was now a thing of the past, for the ship of his genius had put forth upon the boundless waters of the *Divina Commedia.*

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[1] A close comparison with the first canzone of the *Vita Nuova*, *Donne ch' avete intelletto d' amore*, makes this quite clear.

The Electric Arc in Chemical Industry

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The most obvious uses to which electricity has been put in the last fifty years, a time which the future historian will no doubt label as the electrical age, have been in the realm of telegraphy, locomotion, artificial light, X-rays, and the transmission of power. But one development, although more in the background, is not less fundamental in importance—the application of electricity to the crucible of the chemist. By this alliance with chemistry Galvani, Volta, and others first achieved systematically the production of electricity, and Davy, in breaking up chemical compounds into their constituent elements by means of an electric current, demonstrated the molecular structure of matter. From this early time in the nineteenth century onwards, as improved methods of producing an electric current in increasing magnitudes were discovered, one of the first experiments to be tried with the new power was its effect on chemical change. In all instances experiments were first done in a laboratory, scientifically and on a small scale, but the industrial application of electricity was always kept in view, and the course of research was largely guided by industrial needs.

It is noteworthy that a very large share both of the pioneering work in industrial electro-chemistry, and of purely scientific discoveries which are the basis of these processes, was done by workers of this country. The lead, however, in the development of these industries has, in nearly every instance, been left to other countries, where large-scale industrial enterprises are not characterised by the same degree of inertia as at home. Nevertheless, the development in this country has been very rapid. As recently as 1887, a noteworthy landmark was created in the construction, for the electrical production of aluminium alloys in Staffordshire, of an electric generator working the then record production of 500 horse-power. To-day, the installation of turbo-generators of 50,000 horse-power passes without public notice, and it is hardly a matter for comment that at least one electric supply company in this country distributes coal-generated power approaching in magnitude the total developed capacity of the Niagara Falls.

In one respect our country appears to be at an obvious disadvantage, namely, in the scarcity of waterfalls which can be harnessed for the production of power. For this we have largely to use coal, and as coal is dearer than water, the utilisation of large water powers such as exist in Scandinavia and America seems to offer a marked advantage economically over steam-power stations. But, fortunately for this country, present-day tendencies have already reversed this position. For the most favourable water-powers in accessible parts of the world have already been harnessed, and further developments can only be made at greater cost and in places farther afield, while, in the case of steam power, continual progress in power-development is being made, with a consequent increase in economy. The operation of this factor is, indeed, now leading to a redistribution of electro-chemical industries from large water-power centres like Norway and Niagara, to districts near the coal-fields where, incidentally, there are available also the very large supplies of water needed for cooling modern condensers.

Apart from the commercial bearing of this subject, there are several directions in which electro-chemistry is of vital and national interest. The present discussion of this subject will be limited to two of the more outstanding of these developments:

(1) The manufacture from the atmosphere of nitrogen compounds which form the basis of fertilisers and explosives. In this electrical synthesis, the starting-point or raw materials used consist solely of the earth's atmosphere and water, together, in some cases, with lime.

(2) The preparation of alloy-steels of extreme hardness and tensile properties. These products are utilised in the manufacture of high-speed cutting steels, and for the construction of the armour plate of battleships. It is largely to the special properties of this metal that we owe our margin of superiority in naval armaments.

I

The fixation of atmospheric nitrogen is based on the scientific discovery of Cavendish, as early as 1784, that nitrogen can be made to combine with oxygen, by exposing both gases to an electric discharge. This reaction was investigated later more completely by Lord Rayleigh in 1897, and the industrial manufacture of nitric acid by this means was first undertaken by McDougal and Howles at Manchester in 1900.

The stimulus which has, in recent years, been given to this enterprise was created by the realisation that the world's supplies of nitrates, which have resided hitherto mainly in the saltpetre beds of Chile, are within a measurable distance of exhaustion. Moreover, the experience of the recent war has emphasised the disadvantages of fetching from so great a distance the material which forms the primary requirement of agriculture and of all explosives. There is, however, a source nearer home. The air over a single square mile of the earth's surface is estimated to contain about 20,000,000 tons of nitrogen, which is approximately equivalent to thirty times the quantity of *combined* nitrogen contained in the world's production for the year 1913 of Chile nitrate and ammonium sulphate, an alternative source. The conversion of this into the nitrogen compounds so sorely needed in the arts of peace is therefore a most important chemical and engineering problem.

One of the main processes for accomplishing the artificial production of nitrates consists in subjecting air to an electrical discharge or so-called high-tension arc. By this means, the nitrogen and oxygen are induced to combine, giving a compound which in contact with more air reacts with water to give nitric acid. The processes may be represented approximately by the following formulæ :

$$N_2 + O_2 = 2NO \text{ (nitric oxide)}$$
$$2NO + O_2 = 2NO_2 \text{ (nitrogen dioxide)}$$
$$4NO_2 + O_2 + 2H_2O = 4HNO_3 \text{ (nitric acid)}$$

The addition of lime and ammonia then give respectively calcium nitrate, which can be applied as a fertiliser, and ammonium nitrate, which forms the basis of explosives.

The electric arcs used in chemical processes are of two distinct types, the high-tension arc and the low-tension. The former is identical with a miniature lightning discharge continuously maintained, and is produced by a small quantity or volume of electricity at a very high potential or pressure, while the latter is obtained by the passage of a large current at a low potential between two adjacent poles or electrodes which are thus raised to their volatilisation temperature and yield the vapour needed to conduct the current.

One of the main types of apparatus employed in Norway for effecting the union of nitrogen and oxygen is illustrated in Fig. 1. In the type shown, known as the Birkeland-Eyde process, a current of air is drawn through a narrow drum-shaped enclosure in the centre of which a high-tension arc is formed between hollow copper tubes through which water circulates. By means of a magnetic force, which is applied on the outside of the arc, a discharge is caused to spread out in the form of a large fan and fill the space traversed by the air, which emerges with a large content of oxides of nitrogen. In the installation seen in Fig. 1, forty-five of these furnaces are in operation, and each furnace consumes electric energy to the amount of 4,000 horse-power.

In another type, designed by Schönherr, the air is passed, at a high velocity, up vertical towers, and the high-tension arc is adjusted to extend in rod form axially through the centre of each tube, for a distance of 25 feet. Each of these units consumes 1,300 horse-power of electric energy.

The oxides of nitrogen, in all processes, are conducted to a separate building, where they are passed up a series of towers 100 feet high, containing pieces of quartz down which water percolates. Nitric acid is thus formed, and later converted into nitrates as required.

The factories in Norway are situated at Rjukan, a somewhat isolated district possessing abundant water power which furnishes all the energy required. One

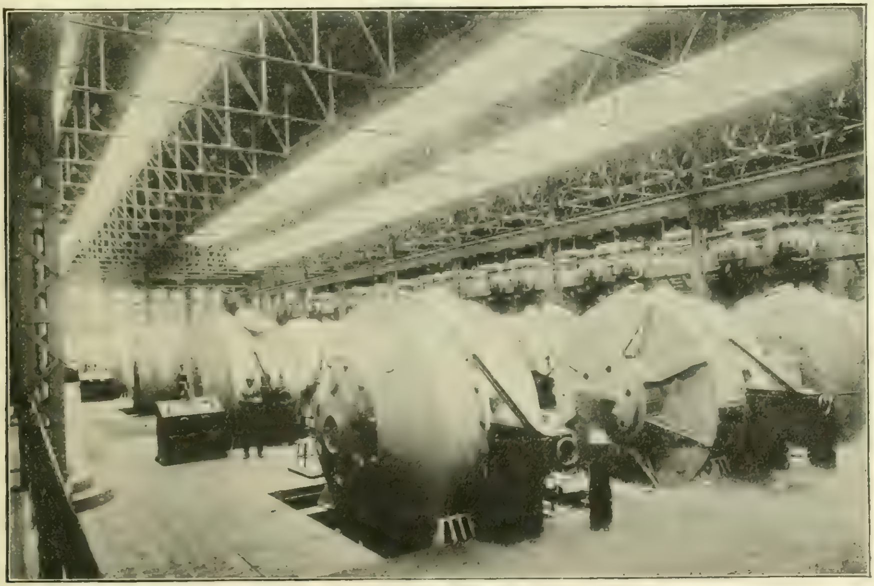

FIG. 1. BIRKELAND EYDE FURNACES AT SAAHEIM, SWEDEN.
(The Norwegian Hydro Electric Nitrogen Company.)
(By kind permission of Messrs. Longmans, Green & Co.)

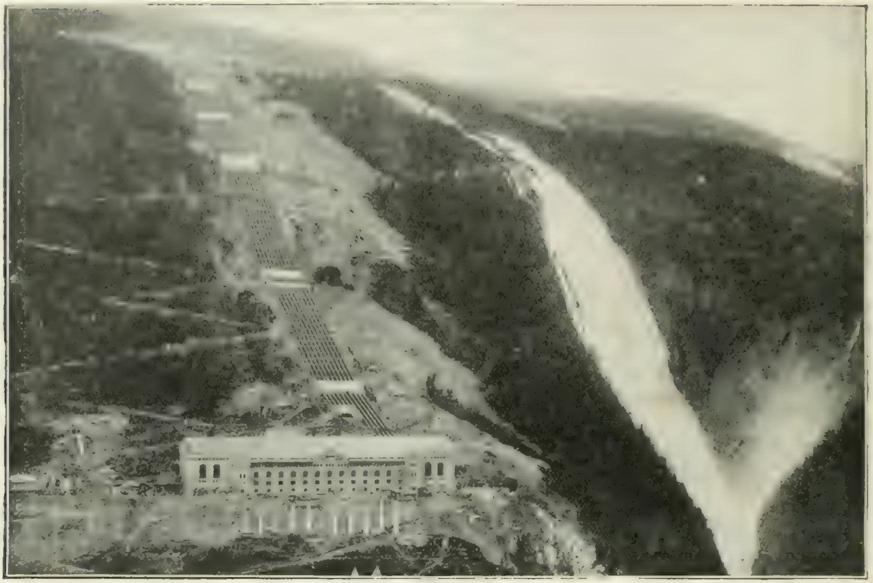

FIG. 2.—THE POWER STATION AT VERMORK, SWEDEN.
(By kind permission of Messrs. Longmans, Green & Co.)

of these power-developments is illustrated in Fig. 2. The supply of water is there derived from Lake Mösvand, 3,000 feet above sea-level. From there the water is led for about three miles through a tunnel in the rock, to a distributing basin or reservoir excavated from the rock, and thence, as illustrated in Fig. 2, down ten steel pipes 4 to 7 feet wide through a fall in level of 940 feet, to the turbines at the base. Each turbine generates 14,500 horse-power, so that altogether 145,000 horse-power is generated. After issuing from this power station, the water is again utilised through being led, in a similar manner, to a second station about 1,000 feet lower down, where a further 162,000 horse-power is developed. Still further possibilities in power generation at the first site are revealed in the surplus water seen in the photograph, which at present serves only for display.

It is of interest to note that in the development of these factories in Norway, the co-operation of Germany was extended to the Norwegian Company, through the agency of the *Badische Anilin und Soda Fabrik*[1] and other allied organisations. Before the war, however, the German interest was withdrawn and, with some foresight, the process was installed in Germany. However, the output of the Norwegian factories, which, after 1916, exceeded 50,000 tons of ammonium nitrate annually, formed a material contribution to this country's supplies of explosives.

II

The experimental manufacture of steel in an electric furnace falls to the credit of this country through the work of William von Siemens, in 1878, and Ferranti, who developed the first type of induction furnace in 1887. Electric furnaces, which are now widely used for the production of steel of all classes, and which have already largely supplanted the "crucible" process, are generally operated by the principle of the low-tension arc. An example of this form of arc is seen in everyday life in the flashes which appear from the trolley poles of cars, and from the rails at places where the surface is uneven or coated with foreign insulating matter. An electric discharge is thus produced which, through its excessive temperature, leads to a volatilisation of some of the metal, thus giving the appearance of a luminous flame. The principle generally applied in electric furnace operation is that of causing an arc to play between a large block or electrode of carbon (or a series of such electrodes) and the surface of metal or material in the crucible to be treated. In this way, temperatures can be reached which are well beyond the zone of those given by any form of fuel-heating. The temperature is, in fact, only limited by the boiling-point of carbon or other materials in the path of the arc, and may be as high as 7,000° Fahr. A second advantage is that the conditions can be adjusted to give temperatures of any lower degree as desired, while the use of electricity enables a careful and convenient adjustment of the heating to be made.

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[1] Where the big explosion on the Rhine recently took place.

Fig. 3 illustrates a bath of steel during the pouring operation. This metal has been prepared by submitting a charge of cast iron with certain alloys and fluxes for a few hours to the high temperature of electric arcs formed between the three superposed carbon electrodes and the surface of the slag.

The main incentives to the development of electric furnaces in the iron and steel industry have been the exacting requirements of the present-day engineer. The demand for high-grade material which, on a large scale, can only be met satisfactorily by electro-metallurgical methods, is particularly in evidence in the case of metals for cars and aircraft machinery, and particularly in America, for the steel rails necessary to meet the increasing weight and speed of rolling stock. Apart from a field of its own which electricity has established in the above instances, the application of electrical heating methods is gradually extending over the whole field of chemical and metallurgical technology. For instance, in certain countries, the electric furnace has entered into successful rivalry with, and proved its overall superiority to, the modern blast furnace for producing cast iron, which in its present-day efficiency and economy is generally put forward as the model of fuel-heating processes. The electric smelting of iron ores has become mainly established at several centres in Sweden where cheap water power is available. A typical plant in use for this purpose is a modified blast furnace of the ordinary type. The charge is admitted down a tall shaft to the melting chamber at the base, where it is submitted to the heating action of arcs from a number of electrodes spaced equidistantly and traversing the roof of the chamber. The electrodes are of moulded carbon, 2 feet in diameter and 4 to 5 feet long. The gases produced from the reaction, which when burned give out great heat, are led through the column of descending charge and cause a partial reduction and preheating of the ore. The hot gases are withdrawn from the top, and a portion of them is again admitted at the base and thus continuously circulated, while the remainder is utilised in heating steel furnaces and for generating power. These furnaces are now constructed in larger sizes; units to the number of about twenty, each consuming 10,000 horse-power, are now in operation in Sweden.

The electric smelting of iron ores can best compete with the older-established and highly-efficient blast furnace in districts where suitable ore and cheap power is available, but where fuel is scarce. Some form of carbon is, of course, necessary for the reduction of the ore even in the electrical process, but a smaller amount is used in the electrical heating than where, in the form of coke, it is used also to produce heat in the blast furnace. Apart from the question of the relative economies of coke and electrical energy, a further consideration is the improved quality of iron made electrically. This is due to the reduction of contamination of the iron by the impurities contained in the coke. The usual Swedish practice is to utilise charcoal as the form of carbon, and thus produce material of the special qualities of the well-known Swedish charcoal-iron. This product was formerly produced in charcoal-heated blast furnaces, and the saving of charcoal effected by the electrical procedure represents the main factor in its economy.

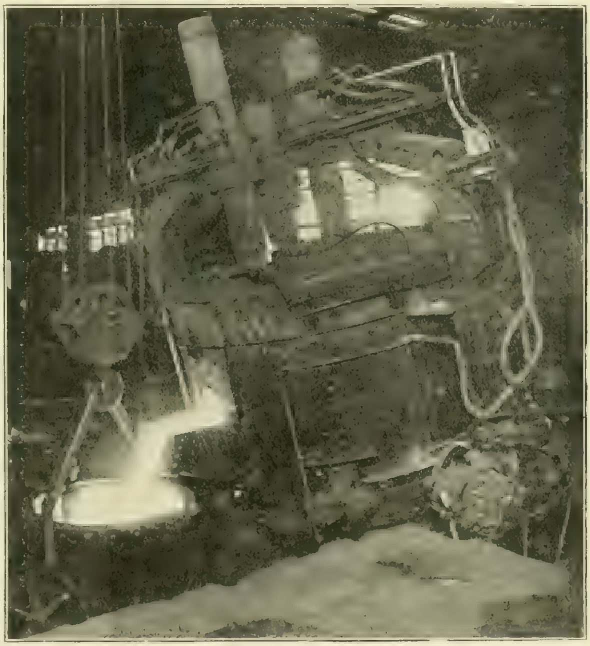

FIG. [illegible]. BOOTH HALL ELECTRIC FURNACE.
(By kind permission of Messrs. Longmans, Green & Co.)

In considering the position of electro-chemical enterprises generally, we shall find that the main obstacle offered to their development in the nineteenth century was the necessity of generating specially the large amount of electrical power required. At the present time the most economical way of obtaining electrical energy is to have it generated in large centralised generating stations situated near the coalfields and distributing the power electrically. Such stations are developing rapidly, because they offer the most economical method of power generation. For these undertakings, of course, coal is a necessity. A very considerable economy is effected by them, partly because of the large scale of operation, and partly because the distribution of power over large areas for miscellaneous services such as factories, railways, and lighting, leads to a more favourable balancing or averaging of the consumption, known as the load factor.

The future interests of this country can be regarded with equanimity, despite the prospect of the exhaustion of our coalfields some day. That day is still far off and, by the time it comes, engineers may have harnessed tidal energy, a source of power now under serious consideration. There is, further, a more remote possibility of the employment of the internal heat of the earth. As with present large power stations, it may be assumed that power from these sources, when it is generated, will be distributed electrically, and thus complete the inception of the electric furnace in chemical industry.

The Problem of Unemployment

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UNEMPLOYMENT is not a new discovery ; it is a social ill which has existed in this country since at any rate the sixteenth century.[1] It appears to be of the nature of a disease, like influenza, cases of which are present all the time, but which does not attract much attention in a community accustomed to it, until there is a sharp and widespread outbreak. There is always some unemployment in the community, but nobody ordinarily worries much about it ; from time to time, however, it spreads widely and assumes alarming proportions. Public interest is then aroused, the evils of unemployment are recognised, and efforts are made to combat the outbreak. The community is suffering from a particularly bad outbreak of unemployment at the present time, and it will be worth our while briefly to examine the problem.

I

It has long been recognised that the state of employment is subject to periodic changes, that a boom in trade is followed by a slump in trade, that the slump in its turn is succeeded by another boom, and so forth. It is not my intention in this short article to discuss the characteristics and causes of ups and downs in trade. Here we shall accept the fact that we are suffering from a bad slump in trade and consequent unemployment, and we shall consider the special conditions which appear to be associated with the present slump. Every depression in trade has a certain individuality of its own, which differentiates it from other depressions, but usually the special conditions connected with a slump are comparatively unimportant compared with the general conditions common to all slumps. In the present case, the special conditions appear to be unpleasantly numerous.

In order to study the special conditions associated with the present slump, it is desirable to classify them. In the first place, we may separate (1) what we may call the special features of the present outbreak of unemployment from (2) the special influences which are accentuating the outbreak. In the second place, we can divide the special influences into three classes : (i) those arising from the character of the post-war boom in trade ; (ii) those which are an aftermath of the war ; and (iii) other special influences.

1. The special features of the present outbreak of unemployment appear to be its suddenness and its acuteness. Its suddenness arises from the character of the post-war boom and is referred to below. In what concerns the acuteness, three things seem to have accentuated it in appearance, if not in reality :

(*a*) Unemployment during the last year or two of the war was abnormally low, it was almost non-existent. Whereas during ordinary booms in trade the average number of unemployed trade unionists has rarely fallen below 20 or 25 per 1,000, the number was as low as 4 per 1,000 in 1916, 7 per 1,000 in 1917, and 8 per 1,000 in 1918 ; even during the summer of 1920 it was below 20 per 1,000. The present figure of 165 per 1,000 is contrasted in people's minds, not with a figure of 20 or 25 per 1,000, a sufficiently striking difference, but with a figure of 7 or 8 per 1,000, a perfectly staggering contrast. Instead of unemployment being about eight times as bad as during an ordinary spell of good trade, it is approximately twenty times as bad as during the abnormal trade conditions of two or three years ago.

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[1] See Leonard, *Early English Poor Relief*, for details of the problem of unemployment in the sixteenth and seventeenth centuries.

(*b*) The interval which has elapsed since the last spell of severe unemployment has been unusually long. The last years of depression were 1908 and 1909. If it is admitted that juvenile workers are not seriously affected by unemployment, it follows that no one who was under 18 in 1909, or under 30 to-day, has had practical experience of a serious spell of unemployment before the present outbreak. Every outbreak of unemployment is an unpleasant novel experience to a group of young workers; in 1908 the group was very small, as the last previous year of bad trade was 1905. In 1908 a serious liability to unemployment was a new experience only for youths and girls of 18, 19, and 20. At the present moment the group of novices, so far as unemployment is concerned, is some three or four times as large as the corresponding group in 1908, for it consists of all adult workers under 29 or 30 years of age. Furthermore, the length of the spell of good trade has caused the dread of unemployment to lose much of its poignancy even for older workers, so that the present severe outbreak must come as a most disagreeable experience to older as well as to younger workers.

(*c*) Whilst the general public, in judging of the present state of unemployment, is no doubt influenced by the contrast with the favourable employment conditions prevailing in recent years, and by the length of the interval since the last slump, it is probably also influenced by the new form in which unemployment statistics are published. With the wide extension of the unemployment insurance scheme, it has become possible to ascertain that x persons are unemployed in this country at a particular time, instead of merely learning that y per 1,000 trade unionists are unemployed. Most people are probably much more impressed by the statement that 1,603,369 persons were unemployed at the end of August, than by the statement that 16·5 per cent. of trade unionists were then out of work. The new statistics have a tendency to magnify in the minds of the public the extent of the present problem.

2. The special conditions which are influencing unfavourably the present slump in trade are to be attributed in a large measure to the war. Students of economic history are well acquainted with the fact that a war tends to be followed in the first instance by a boom in trade, and then by a bad slump. A post-war boom is itself an effect of war conditions, so that the influences exercised on the present slump by the preceding boom were caused indirectly by the war, and might not unreasonably be grouped with the war influences. We prefer, however, for the sake of clearness, to class them separately and to consider them first.

(i) (*a*) The post-war boom was a very feverish and speculative affair. The amount of goods changing hands was probably very modest compared with the amount changing hands in a good pre-war year like 1912 or 1913. The business community and the general public were very optimistic after the Armistice, and no considerable flow of new orders was necessary in order to place a tremendous strain upon industry engaged at the time in trying to change over from war output to peace output. In many trades producers were unable to place even a moderate supply of goods upon the market; the limitation of supplies, in conjunction with the increased demand, caused prices to soar rapidly to dizzy heights unknown in ordinary booms. Buyers, realising how difficult it was to secure delivery, frequently ordered two or three times as much as they wanted in the hopes of obtaining something like the amounts they really required. This practice also helped to drive up prices. Fortunes were being made, though mostly on paper; industrial extensions and developments of all kinds were planned; the public, its appetite whetted by the prospect of share bonuses and substantial dividends, was prepared to finance industry freely. People bought shares indiscriminately in fresh concerns, in reconstructed companies, in new amalgamations and in well-established old firms. The boom was much too fevered to last long; it was soon discovered that industrial expansion was on anything but a sound basis; the tide of trade turned, and as the flow had been both great and rapid, not unnaturally the ebb was also great and rapid. The sharp reaction in prices caused all firms holding stocks to be faced with heavy losses; business houses which had over-ordered during the boom now unexpectedly found their whole orders being executed at prices well in excess of current quotations; they had either to accept delivery and shoulder heavy losses, or cancel orders and attempt to throw the losses back on to the sellers. In either case, the effects were very depressing on business enterprise, and employment suffered accordingly.

(*b*) Owing to the post-war boom being so short, a considerable number of demobilised men never had a chance of being properly absorbed into industry. Consequently they very quickly found themselves out of work when the tide of trade turned.

(ii) (*a*) Though the least fundamental in character, the war influence which has perhaps had the most immediately depressing effect on industry has been the great sales of war stores. At first, owing to the scarcity of goods of all kinds and the inability of producers to meet the public demand, the sale of war stores acted as some check on the rise in prices without harming producers; but when the first rush of new business was over, the large supplies of goods remaining on the hands of the Disposal Board, and of firms which had purchased war stores in bulk and not yet disposed of them, began to act as a wet blanket on business enterprise.

(*b*) The financial disorganisation caused by the war is having a very prejudicial effect upon trade and employment. This operates in two entirely different ways. (1) It has led to a marked rise in the rate of interest which seriously checks new enterprises requiring capital. A development which might be soundly financed, if money could be borrowed at 3½ or 4 per cent., may be outside the scope of practical politics if money has to be borrowed at 6 or 6½ per cent. (2) The foreign exchanges are badly out of joint. It is not merely that our producers are liable to be undersold by certain Continental countries, and that many foreigners cannot afford to buy our goods because sterling stands at such a high premium in terms of their currencies, but that, owing to the violent fluctuations in the foreign exchanges, a large speculative element has been introduced into all foreign trade, which tends to discourage our manufacturers from selling abroad.

(*c*) The high costs of production since the war are restricting sales; amongst the factors leading to high costs of production may be noted. (i) the enhanced rate of interest referred to above; (ii) the high prices of raw materials; (iii) high rates of wages, and this in its turn leads to high prices of raw materials, e.g. coal; and (iv) low daily rates of output. In many ways the last is the most serious of all. It is partly accounted for by reduced hours of labour, but the output per hour in many industries has fallen, whereas reduced hours should enable a higher hourly output to be secured. High wages themselves are not incompatible with low costs of production, but high wages in conjunction with slow working makes production very costly.

(*d*) The war has left most of the combatant countries seriously impoverished and exhausted, and with greatly reduced purchasing power. Quite apart from the problem of the foreign exchanges mentioned above, several of the Continental countries are obliged to devote practically their whole energies to feeding themselves and repairing the damages of war, and they consequently have no surplus products available to exchange with other countries. In view of the importance of foreign trade to this country, the temporary loss of several Continental markets is very prejudicial both directly and indirectly. It is not merely that Continental countries are buying less from us, but they are also buying less from various overseas countries, e.g. coffee from Brazil and cotton from India, a fact which diminishes the purchasing power of overseas countries in our markets.

(iii) (*a*) Much the most serious of the other special influences which are accentuating the present outbreak of unemployment is the series of big strikes which have occurred since the Armistice, e.g. the moulders' strike, and, in particular, the recent coal dispute. Industrial disputes nearly always throw some workers out of employment, quite apart from those who are on strike, or who are locked out, and in the case of the coal dispute whole industries have been closed down for want of fuel. Restarting an industry after it has been closed down is never a very rapid process, but it is particularly slow when it occurs at a time of general trade depression.

(*b*) Certain industries, in particular the Lancashire cotton trade, are at present adversely affected by the Indian trade boycott.

II

Even a brief examination of the problem of unemployment would hardly be satisfactory without some reference to the possible measures which may be taken to remedy the evil. The ideal to be aimed at is undoubtedly the restoration of industry to ordinary working conditions, so that a full output can be disposed of at remunerative prices. In what way, if any, can a return to good trade be hastened by State action? Temporarily, the State can stimulate trade in at least two ways: on the one hand, it can place huge orders in various directions as happened during the war, when the State was the largest customer of most industries; on the other hand, it can inflate the currency and cause prices to rise, which encourages industrial expansion. This also tended to happen during the war. These "remedies," like alcohol and drugs administered to human beings in strong doses, stimulate the patient for a time, but then have very unpleasant after-effects, the patient ultimately feeling more miserable than he did originally. Industry is suffering now from the unpleasant after-effects of big Government orders and of war-time inflation. The war-time trade prosperity was entirely artificial, and just as a repetition of strong doses of alcohol or drugs would sooner or later kill the patient, so a repetition of excessive Government orders and inflation would sooner or later lead to national bankruptcy. As a State drugging of industry with excessive orders and inflation cannot restore natural trade prosperity, and will ultimately involve most pernicious consequences, such a policy cannot be recommended, and it is therefore necessary to explore other possible lines of action.

The methods of dealing with unemployment can be divided into two classes. (1) those concerned with the eliminating of the causes of the evil, and (2) those concerned with alleviating the evil when it has arisen. Whilst it is obviously true of unemployment, as of illness, that prevention is better than cure, the difficulty is to discover preventive measures of an adequate and practicable kind; it is consequently necessary to fall back on palliatives to a larger measure than would at first sight appear desirable.

1. (*a*) The causes of general depressions of trade might be counteracted, to some extent at least, by regularising the national demand for labour. If the Central and Local Authorities arranged programmes of their less pressing work for several years in advance, for a period roughly corresponding to a cycle of trade, and gave out as little of the work as possible during good years, and as much as possible during lean years, something would be achieved towards diminishing the severity of the slumps.

(*b*) The time lost between losing one job and finding another could be reduced by an efficient system of Labour Exchanges which would place workers looking for jobs and employers seeking labour promptly in touch with one another. Efficient Labour Exchanges could also help to dovetail together winter and summer seasonal employments, and to eliminate casual labour by concentrating the demand for and the supply of labour in a few definite places.

(*c*) Training centres might be established with the twofold object of assisting workers to acquire a new trade, where their old one was overstocked, or personally unsuitable, and of placing inefficients upon their feet by giving men the training they previously lacked.

We have not space critically to examine any of these suggestions, to the carrying out of which there are undoubtedly serious practical difficulties. At the moment, however, when the country is suffering from an acute outbreak of unemployment, the immediate problem is to find palliatives; it is a case for bottles of medicine and not for preventive measures.

2. (*a*) Manual workers are not the only people who suffer from irregularity in employment and in income. The professional classes, for example, are subject to similar fluctuating conditions. Their way of meeting the problem is to lay by some of their income in good times in order to provide for bad times. This arrangement, even if successfuly carried out, does not eliminate lack of work at certain periods, but it does do away with the worst consequence of unemployment, viz., absence of the means of buying the necessaries of life. In the first place, it is open to manual workers, as individuals, to adopt the same method. In the second place, as an alternative or in addition, they may adopt a plan by which they form themselves into groups and provide jointly against the risks of unemployment. This is a system of voluntary insurance such as the out-of-work benefit schemes provided by trade unions. In the third place, the State may intervene and establish a system of compulsory insurance, financed from contributions made by workers, employers, and the State itself. Under the existing State unemployment insurance scheme, so far as different trades are covered, all adult workers on the one hand, and all employers on the other, pay equal contributions, although the liability to unemployment varies considerably from industry to industry. It has been suggested that each industry should assume financial responsibility for its own unemployed, and in theory, if not in practice, there is a good deal to be said for the suggestion.

(*b*) When there is not enough work to provide employment for all in an industry, the work may be rationed, so that all may be employed part-time, instead of some being discharged whilst the rest work full-time.

(*c*) Relief works may be established, though this method is by no means free from difficulties. The selection of the work is one difficulty; the fact that it is almost impossible to find suitable tasks for skilled workers is a second; the fixing of rates of pay is a third; the costliness of such undertaking is a fourth; and arising out of that, the question as to what Authority is to finance the relief works is a fifth.

(*d*) Relief orders may be placed by Public Authorities, the work to be carried out by the ordinary channels of industry and not through special undertakings as in the case of relief works. The orders given out would be either to supply in advance future requirements of the Central and Local Authorities, or else to provide a stock of standard goods to be sold at home or abroad when trade conditions were more favourable. The former type of orders, which are along the lines of the scheme for the regularisation of the national demand for labour referred to above, would appear much to be preferred to the latter type of orders. Production for stock is a very ticklish operation, liable to depress the market at a later date, and to cause the holder of the stock heavy losses through depreciation. Production for stock may easily develop into a gigantic speculation; private producers, when they themselves shoulder the risks involved, are the only people likely to handle the delicate problem with the right combination of boldness and caution.

(*e*) The State may create or guarantee fresh credit in favour of industry and trade. This policy appears to be first cousin to the currency inflation policy referred to previously. It is doubtful whether there is any lack of credit facilities at the present time; the trouble seems to be that there are no sound uses to which fresh credit can be put.

(*f*) Experience shows that it is not easy to harmonise "relief" and "work," so that "relief works" may be abandoned in favour of, or supplemented by, "relief" or "maintenance," as it is nowadays frequently called. The assistance provided by Boards of Guardians and the "out-of-work donations" paid by the Central Authority after the Armistice are examples of relief or maintenance. Abuses very easily creep into the system of granting relief or maintenance, as the conditions described in the Poor Law Report of 1834 clearly show, and a very efficient administration is necessary, if the worst dangers of demoralising the recipients and of undermining the incentive to work are to be avoided.

III

The responsibility for unemployment cannot be laid at the door of any one party. Unemployment appears to be primarily the price we have to pay for being an industrial state largely dependent on foreign trade. The evil is practically unknown in self-supporting agricultural communities. Employers, workers, and the Government, by their actions or want of actions, may accentuate the evils of unemployment, but the fundamental causes appear to be beyond their control. It is not as if the problem had not been carefully investigated and studied. The trade depression of 1904–5 led to the appointment of a very strong Royal Commission on the Poor Laws and the Relief of Distress, which reported at stupendous length in 1909. The two chief recommendations in relation to unemployment—the establishment of Labour Exchanges, and the introduction of compulsory unemployment insurance—were carried into effect, yet we are now suffering from more acute unemployment than that recorded at any previous outbreak.

It is difficult to avoid being pessimistic in contemplating the somewhat gloomy picture we have had to draw; acute unemployment is a great social evil; several of the so-called "remedies" are liable to recoil with the most serious consequences upon the community that applies them, yet efforts must undoubtedly be made to alleviate the distress. The one reassuring thought in the situation appears to be our knowledge, gained from considerable experience, that just as bad trade follows good, so good trade follows bad. As the slump came so suddenly, it is not unreasonable to hope that there will soon be a turn in the tide of trade.

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Timgad: the Pompeii of Algeria

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Timgad, or Thamugadi, as its founder called it, was until recent times a buried Roman city in Algeria, about a hundred miles from the northern coast, and a little more than twenty from the nearest French settlement at Batna. Now that it is uncovered it is the most curious sight in North Africa and can be compared only with Pompeii, that famous city on the bay of Naples, overwhelmed by the ashes from the great eruption of Vesuvius in A.D. 79, which the Italians have been gradually uncovering for the last fifty years. In some ways Timgad is more typically Roman than Pompeii. Pompeii had grown out of an earlier Oscan town. Its architects never had a free hand, and it is in consequence full of odd corners and straggling spaces. It was a city of pleasure for the idle rich and is built of brick. Timgad is a model town, the greater portion of which was built at the same time, and on a definite plan at the command of an Emperor. It was therefore compact and well arranged as befitted a town that might at any moment have to turn itself into a fortress if attacked by the savage hill tribes to the south. It was founded in the year A.D. 100 by the Emperor Trajan, and is built entirely of stone. In the proud words of the inscriptions still to be read on the arches to the West and North, "The Emperor Cæsar Nerva Trajan Augustus Germanicus, son of the Divine Nerva, Sovereign Pontiff, invested for the fourth time with Tribunician Power, thrice Consul, Father of the Fatherland, founded the colony of Marciana Trajana Thamugadi by means of the third Augustan legion, when Lucius Munatius Gallus[1] was legate of Augustus with prætorian powers." This Gallus was what we should call the Army Corps commander in the Province. The town was almost certainly completed before the Emperor's death in 117.

It was founded in consequence of a change made by Trajan in the scheme of defence of the southern frontier of Numidia. The great Aurasian range of mountains which runs almost due east and west was then as now the natural line of defence against incursions from the south. Rome held the frontier, as every conqueror must hold it, by means of the great military road skirting the northern slopes of the mountains. The headquarters of the Roman military force in the province, the third Augustan Legion, had been fixed by Augustus at Theveste (now Tebessa), at the eastern end of the Aures range. Trajan moved the legion westward, probably to the neighbourhood of Mascula (the modern Khenchela), and while it was there perhaps a detachment from it was stationed on the site of Timgad in order to guard the Foum-Ksantina gap. In A.D. 100 a colony was founded at Timgad. It was the usual civil settlement which was essential to a permanent Roman camp. It was not a garrison town, though built so as to be easily defended, but was the commercial centre and recruiting-ground for the neighbouring camp and the nursery of Roman civilisation in the surrounding region. By A.D. 123 the camp of the legion was fixed thirteen miles westward of Timgad, at Lambæsis.

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[1] Not to be confused with the soldier-poet Gallus, the friend of Vergil, on whom see Discovery, vol. i, p. 3.

MERIDIAN STREET AT TIMGAD.

(By the courtesy of the Clarendon Press, Oxford.)

Like all Roman military colonies, Timgad is built like a Roman camp. In its original form it is almost a true square occupying about thirty acres. The gates in the centre of the northern, western and eastern sides still survive. If the normal plan had been followed, the town would have been divided into four more or less equal squares by the cruciform intersection of the two main streets, which correspond to the two main roads that always intersect a Roman camp. But here the street which runs from north to south (the *Kardo maximus*) is not continued, as it should be, in a straight line after meeting the Forum in the centre of the town, but is diverted to the west. The street from east to west (the *Decumanus maximus*) runs nearly straight and was the most important in the town because it was a section of the great road from Lambæsis to Theveste. The main stream of traffic passed through it, and many of the more important public buildings are to be found in it or grouped near it. A number of side streets parallel to the *Decumanus* or to the *Kardo* divide the area of the town into small square *insulæ* or house-blocks, containing as a rule two houses apiece. There were no slums in Timgad because there were no poor in a population consisting mainly of merchants and time-expired soldiers. The general effect is a pattern like a chess-board, disturbed here and there by the larger spaces taken by the Forum and by public buildings such as the theatre, the market, and the public library. This chess-board pattern is still the most convenient plan for a military town, and the French have adopted it at Batna. The *Decumanus* and the *Kardo* are both carefully paved with large slabs of blue limestone laid so that their edges run diagonally across the street, in order to secure greater strength against the impact of wheeled traffic. This pattern of paving is still to be seen in the main streets of Naples. It is far superior to the irregular pavements of Pompeii. These two streets with their lofty colonnades on either side—a fashion of architecture introduced probably from the East, after the conquest and foundations of Alexander had taught Eastern builders to copy Greek models—must have been one of the most striking features of the little town. Even in its decay the *Decumanus*, as one looks down it with the sun setting behind the great western arch, has an air of grandeur to which few other ruins of the same size can pretend. The town was well supplied with water from public fountains which drew their supply from the neighbouring Aïn-Morris. It had also a very complete system of drainage. The sewers which ran beneath the main streets were built of stone, and still survive as perfect as when they were first used. They carried the sewage, and still carry surface water, down to the plain below. At frequent intervals, in the streets above, there are pierced flag-stones, leading to manholes, which served for ventilation and inspection. Enough is left of the public latrines by the side of the Forum to show that they were constructed on the grand hygienic principle of *tout à l'égout*. One feature of the town will strike the modern visitor who, perhaps, thinks that municipal hygiene is an entirely modern invention—the size, number, and splendour of the public baths. These establishments must have played a great part in the life of a citizen of Timgad. On one of the broad steps on the north side of the Forum is a rudely chiselled inscription which reads: "HUNTING, BATHING, GAMING, LAUGHING, THIS IS LIFE." But there is death as well as life in such enervating ideals; and even the most modern town need not wish to be as advanced as Timgad with its eleven public baths, some of them of considerable size and with luxurious appointments. The bath in Roman lands provided all classes of citizens with a centre where they could have not only an elaborate bath—more or less after the fashion of the modern Turkish bath—but also enjoy the advantages of a gymnasium, a social club, a lecture room, and art gallery. While on the one hand it promoted cleanliness, health, comfort, contentment, and even education, on the other it cannot be denied that it must have led to endless scandal-mongering in a small town, and fostered habits of idleness and self-indulgence which caused a mortal lassitude in public and private life. The most impressive remains of ancient baths are, of course, at Rome, where the great hall of Diocletian's Thermæ still survives almost intact in the Church of S. Maria de' Angeli near the main railway station. When the size of the town is taken into consideration, the baths built outside the northern gate of Timgad at some time in the second century are quite as luxurious. They cover an area twice the size of the Forum. They contain thirty-two smaller rooms, used for changing, for the various stages of the bath, and also for stores and service, grouped round three magnificent halls.

But Timgad provided not only for the material comfort of its citizens, but for their intellectual improvement also. On the left hand of the *Kardo*, just before it strikes the Forum, is a semicircular building with a large forecourt which for a long time puzzled the French excavators. It is now proved by an inscription to be the public library of the town, built out of a large legacy left by a patriotic citizen named Rogatianus. The library proper is in the semicircular apse. In the wall are spaces once occupied by bookcases. In the centre between two columns there was doubtless a statue of Minerva. To the left and right of the reading-room were rooms used for storing books. It was the resort of idlers as well as students, and, unfortunately, we know more of the idlers, who have scratched or chipped their worthless thoughts on the columns of the forecourt, than we know of the students.

The last feature in the plan of the town on which I wish to dwell is the admirable system of public markets. There were shops, of course, in the main streets, especially in the *Decumanus*. But the needs of the town were largely supplied by three public markets The most important of these is just outside the original walls, to the south of the western arch. It was built by the generosity of a private citizen named Sertius. Its plan comprises a large, wide open space with a fountain in the centre, surrounded by colonnades and beautifully paved with blue limestone. There are shops to the north and south of the square. Those in the south are arranged like a fan in a semicircular building with a roof supported on columns. The shops had no doors, but stood open to the air, with broad counters of stone fixed upon stone uprights. The shopkeeper had to crawl below with his goods and crawl back with them when the market closed, since there are no signs of any provision for storage. There is an even more elaborate market at the west end of the *Decumanus*, with two semicircular buildings filled with similar stone booths.

How did Timgad perish, and how is it that we can walk its streets to-day with the feeling that the traffic there stopped but yesterday? It prospered for more than four centuries, surviving apparently (for it is hardly mentioned by ancient writers) the attacks of those horrible Christian zealots, the Circumcelliones, and also the brutalities of the Vandal invasion. In 533 Belisarius destroyed the Vandal power by his victory near Carthage, and proceeded by means of his lieutenant, Solomon, to bring the whole of the province of Africa under Byzantine rule. This alarmed the Berber tribes of the Aures, the eternal enemies of every dominant power in North Africa, whether Carthaginian, Roman, Vandal, Arab, or French, and they swept down from their mountains in 535 and burnt Timgad in order to prevent the Byzantines from occupying it. Solomon took possession of the ruined town, but did not rebuild it. He erected a large and powerful fortress to the south, and a new town, with Christian monasteries and churches, sprang up round it and enjoyed a semblance of life for another century. Then came the Arab invasions at the end of the seventh century. For a while the province resisted bravely. The Berbers under their romantic queen, The Kahinah, killed the famous Marabout Sidi Okba in an ambush near Biskra, and in alliance with their former enemies, the Greeks, defeated another Arab general, Hassan ibn en-Noman, at Meskianah in 696. Two years later, however, Hassan returned and routed the Berbers. The Kahinah fled to her mountains cursing the large wooden idol of her tribe, that was always carried before her on a camel. From the heights above she may have seen Byzantine Timgad sinking in flames as her ancestor had seen the old town sink a century before. Then the long night of Islam descended upon both for twelve hundred years. Columns and walls were overthrown by earthquakes and covered by the earth brought down by the rains from the neighbouring hills. The wild vegetation of the surrounding steppe crept over the ruins till little else could be seen above the soil but the great western arch usually known as the Arch of Trajan. Fortunately the Arabs who inherited the land were wanderers who did not seek to build towns for themselves. They were content to pitch their flat brown tents above the ruins, and pasture their flocks of goats and herds of camels. The excavations authorised and subvented by the French Government began in 1880 and have been continued to the present time. They have thrown a flood of light upon Roman life and history by disclosing the authentic features of a daughter city of Imperial Rome.

For a detailed description of the ruins of Timgad see *Guide Illustré de Timgad*, by Albert Ballu (published by Neurdein Frères, Paris), and for further information on town-planning in antiquity see *Ancient Town-planning*, by F. Haverfield (Clarendon Press, Oxford).

Suggestion and Autosuggestion

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It has for a long time been known that a statement uttered in a confident manner by another person tends to be accepted by us as true quite independently of any rational grounds for believing it (such as our knowledge of the credibility of the speaker). Such acceptance by our minds of another person's proposition in the absence of adequate grounds for its acceptance is called by psychologists *suggestion*.

We will consider a typical case of suggestion in everyday life. We want to buy something in a shop. The salesman asks a price which we know is much in excess of its true value. We question his price. He insists in a firm, confident manner that not only is he not overcharging us, but that he is asking less than the true value of the article and that he will lose heavily on the sale. He continues to repeat this, and in time it has happened to most of us that we have bought the article. It was only later when we were out of reach of the salesman's suggestions that we have realised (what we knew at first) that we have paid far more than the article was worth, and that we have been victims of a suggestion. It is clear that, in this case, we have not argued to ourselves that the salesman is probably telling the truth. On the contrary, we know that it is in his interest to be lying. His remark that he will lose on the sale is clearly untrue. We have accepted his statement by no rational process, but by the process of suggestion—the acceptance by our minds of a course of action simply because it has been proposed to us a sufficient number of times in a sufficiently confident manner.

In suggestion, the idea of a belief (or, as in the example just given, a course of action) presented by some other person actually produces in our minds that belief (or that course of action). This passage from an idea to its reality may be called "realisation." It is in this specialised sense that the words "realisation" and "realise" will be used in this article. In suggestion the idea of a belief, a course of action, a state of feeling, or the cure of some ailment is presented in such a way by another person that it is "realised" by the person receiving it.

We find that there are wide differences in the readiness with which suggestions are accepted by different persons, and by the same person under different circumstances. These are generally called differences in "suggestibility." Suggestibility varies with age and sex; children are more suggestible than grown persons, and women are more suggestible than men. Suggestibility is also heightened by anything which increases the prestige of the person from whom the suggestion is received, and by practice. A person who has been put frequently into a state of hypnosis becomes increasingly suggestible.

The state of half-waking which immediately precedes and follows sleep is a condition in which suggestibility is very high. A similar state can be induced artificially and is called light hypnosis or the hypnoidal state. What is called deep hypnosis is a state resembling sleep. Both of these are states of high suggestibility. Hypnosis can be induced by fixing the eyes on a bright point, such as the flame of a candle or the bright reflections in a crystal, by listening to a continuous or rhythmically varying sound, such as the ticking of a clock or the sound of waves breaking on the seashore, or by rhythmical passes performed before the subject's face and body. It can also be produced simply by suggestion in a sufficiently suggestible subject. The operator has only to order such a subject to sleep, and he immediately falls into the hypnotic sleep.

Suggestion has been used as a method in the cure of diseases, and it is in this connection that we shall be principally concerned with it in this article. When a doctor wished to treat a patient by suggestion, it was at one time usual to put him into the hypnotic trance; more usually at the present time he is put only into the state of light hypnosis. In either case, the object is to increase the patient's suggestibility so that the curative suggestions of the doctor may more readily take effect. One objection to the use of suggestion in the cure of disease, and particularly of suggestion under deep hypnosis, is its tendency to increase the patient's suggestibility, with consequent weakening of his independence of character.

This objection is overcome if the suggestion is performed by the patient himself instead of another person. When this is done the process is called *autosuggestion*. There are serious difficulties in the way of successful autosuggestion, but these can be overcome, and we are then provided with a valuable weapon for the cure of some kinds of disease. In the present article, I am going to describe the methods of autosuggestion employed in the New Nancy psychiatric clinic. These are explained in a recent book called *Suggestion et Autosuggestion*, by Charles Baudouin, which has been translated into English by Eden and Cedar Paul. The page references in the present article are to the English translation.

The principal novelties in the New Nancy treatment of suggestion are: their increased emphasis both in theory and practice on autosuggestion, and their enunciation of certain laws of suggestion which will be described later.

In what is ordinarily called suggestion Baudouin distinguishes two steps. First, an idea imposed by the operator is accepted by the subject. This he calls *acceptation*. Secondly, the object of the idea is realised. This he calls *the ideoreflex process* or simply *suggestion*. He considers that the second of these steps is the more important one, and that earlier accounts of suggestion have gone astray by fixing their attention too exclusively on the earlier step of *acceptation*, and regarding that as the important thing in suggestion. The second step is of course a subconscious one. If we accept this distinction and follow Baudouin's use of words, it will be necessary to modify the terminology used earlier in this article. Then we called a person suggestible if he realised readily a suggested idea. But Baudouin uses the word *acceptivity* for the property of accepting a suggestion readily, and reserves *suggestibility* for readiness in carrying out what he calls the ideoreflex process. A person may be highly suggestible in this sense, and yet not be easily influenced by other persons, because his acceptivity is low. It is acceptivity, and not suggestibility, that is an undesirable quality if too highly developed.

If the subject himself puts into operation the ideoreflex process, we have *autosuggestion*. Autosuggestions may either be spontaneous or the result of our own deliberate effort. These are distinguished as *spontaneous* and *reflective autosuggestion* respectively. The case of spontaneous autosuggestion is the simpler one, so we will consider it first.

Spontaneous autosuggestion is a process occurring in the lives of all of us fairly continually, when any idea which has happened to catch our attention realises itself. An opinion, for example, which we have heard often repeated tends to become a belief. When we see a fire freshly lighted, we begin to feel warmer even though it has not really begun to throw out any heat. An illness that we are always talking and thinking about tends to develop.

There are four laws of suggestion developed by Coué (the founder of the New Nancy school) which are so important that I will give them in full:

(1) The *Law of Concentrated Attention*. "The idea which tends to realise itself in this way is always an idea on which spontaneous ATTENTION is concentrated" (p. 114).

(2) The *Law of Auxiliary Emotion*. "When, for one reason or another, an idea is enveloped in a powerful EMOTION, there is more likelihood that this idea will be suggestively realised" (p. 114).

(3) The *Law of Reversed Effort*. "When an idea imposes itself on the mind to such an extent as to give rise to a suggestion, all the conscious efforts

which the subject makes in order to counteract this suggestion are not merely without the desired effect, but they actually run counter to the subject's conscious wishes, and tend to intensify the suggestion " (p. 116).

(4) The *Law of Subconscious Teleology*. " When the end has been suggested, the subconscious finds means for its realisation " (p. 117).

The first three of these laws may perhaps best be illustrated by a case of spontaneous autosuggestion of a particularly unpleasant kind which in some form has occurred to the experience of most people. We may suppose that you have been told to walk along a plank 6 inches wide, resting on the floor, without stepping off on either side. You will find that you are able to do so without any difficulty. If, however, a plank of the same width and of the same rigidity were supported at a great height above the ground so that there was a sheer drop of several hundred feet on both sides, and you attempted to walk along it, you would certainly fall off. This is a case of realising the idea of falling off by spontaneous autosuggestion. Spontaneous attention is unavoidably caught by the idea of falling off, and there is a very powerful emotional accompaniment (of fear or horror) to this idea. These are the conditions described by the first two laws as those under which ideas become realised by spontaneous autosuggestion. If either you could manage not to think about falling off at all, or if you could think about it without any powerful emotion, the danger of falling off would be less. At the same time, the law of reversed effort is illustrated by the fact that your voluntary efforts to retain your balance will not only be useless, but will tend to defeat that end.

As an example of the Law of Subconscious Teleology, we may take a case where what is suggested is either the formation or the cure of some bodily symptom in a disease. It is common for Swiss girls both to produce and to cure warts by autosuggestion. It is clear that they have no knowledge of the bodily changes which produce the warts. The law asserts that this is not necessary for successful autosuggestion. When the end (the formation of the wart) has been suggested, the subconscious finds the means for its realisation (the bodily changes which will produce it). This is obviously a law of the first importance for the use of autosuggestion in the cure of diseases.

The ways in which Dr. Baudouin finds that spontaneous autosuggestion affects us in ordinary life are numerous. The habit of discussing and giving names to our ailments produces an atmosphere of spontaneous autosuggestion of disease which is probably very fruitful in the production of disease. Even when there is an organic ground of disease, the pain in the diseased part attracts attention to it, and thus spontaneous autosuggestion adds something to already existing diseases. He also mentions clairvoyants and such people, whose prophecies tend to germinate in our minds and to realise themselves, so that a prophecy of misfortune may result in that misfortune. There are, of course, also spontaneous autosuggestions which are desirable—thoughts of strength, success, health, etc. It is possible to combat the effects of noxious spontaneous autosuggestions by means of *reflective autosuggestion*.

The difficulty in the practice of reflective autosuggestion is to find an efficient substitute for spontaneous attention. If a voluntary effort is made to think of and realise an idea, the law of reversed effort shows us that it will not be successful. It is for this reason that many persons fail in autosuggestion. They are told to concentrate on an idea. For them concentration means an intense voluntary effort to think of it ; and intense voluntary effort is the condition under which autosuggestion is most certain to fail. Those who have experienced the effects of intense voluntary effort to go to sleep know the condition of hopeless wakefulness which such an effort induces. It will be noticed later that Baudouin himself uses the word " concentration " for a method of reflective autosuggestion, but he is careful to explain that he does not mean by it any kind of voluntary effort. The practical problem to make successful reflective autosuggestion possible is to discover some condition in which voluntary effort is as small as possible, but in which the mind can be kept occupied with the particular thought to be suggested.

The condition between sleeping and waking, which we have already noticed as one of high suggestibility, is a state in which spontaneous autosuggestions are particularly liable to realise themselves. All writers on autosuggestion recommend that a similar state should be induced, in which there is a certain emptiness of mind and suspension of the mental functions. Sometimes, however, they write as if this were a state to be attained by an act of will, and their followers find themselves misled into making strenuous efforts where a relaxation of effort is the principal necessity.

One of the characteristics of this half-waking condition is what is called the *outcropping of the subconscious*. The mind ceases to be occupied with the directed thinking in words which is a voluntary activity, and instead becomes filled with a succession of vague images which are surface effects of the repressed material in the unconscious. A similar condition is found in reverie, that is, in the state in which we have relaxed the voluntary activity of the mind. It is found that those to whom this state of outcropping is most normal are those to whom autosuggestion is easiest, as artists, women, and children.

The first step which Dr. Baudouin suggests in the practice of autosuggestion is an education of the outcropping by the production of these states. This is done by keeping the body motionless and the muscles relaxed while we are resting on a comfortable armchair under conditions as free as possible from such external distractions as noise. The eyes are closed, and the effort of thinking is relaxed, while the mind is allowed to occupy itself with the vague images which float past it. Baudouin speaks of this state of outcropping produced by such a relaxation as *le recueillement*.[1]

Le recueillement, however, is merely a preliminary stage. The equivalent of attention of which we are in search is a condition of monoideism in which we have this condition of outcropping and, at the same time, the mind without effort is permeated with a single idea. This is what Baudouin calls *la contention*. It is what books on autosuggestion mean generally when they speak of concentration. Sometimes, on waking up after sleep, the mind is found to be in this condition ; directed thinking is at a minimum, and at the same time the mind is exclusively occupied with one single idea. This is the condition under which the idea occupying the mind will realise itself as an autosuggestion. In order to be successful in the attainment of the state of *contention*, it is necessary to cultivate both the power of attention and of relaxation. It is suggested that the former should be cultivated by such exercises as learning by heart, and the latter by the practice of *le recueillement*.

So far we have described *la contention* without indicating how it may be attained. This may be done by the permeation of the mind without effort during the period between sleep and waking by the idea which we wish to realise, the idea, for example, of the cure of some illness or weakness. The difficulty is to find a way of keeping the mind permeated with an idea without the effort of attending to it. The way to do this is to sum the idea up in some formula which is repeated over and over again. If we wish to attain *la contention* at other times in the day, we may do so by producing outcropping by the practice of *le recueillement*, and then permeating the mind with the desired idea in the same manner. It is easier, however, to do so if the state of outcropping is not produced by relaxation, but by a method of immobilisation of the attention which has already been described under the name of *hypnosis*.

For the production of the state of hypnosis, the attention is immobilised, i.e. is kept fixed for some time on one object until it relaxes itself spontaneously through loss of interest (and probably fatigue). When it relaxes itself, a state of outcropping is produced similar to that in *le recueillement* or reverie. It has this difference, however, that it favours the attainment of *la contention* with an idea more than does reverie. The reason for this is that in reverie we tend to have dispersion of mind, while in hypnosis the idea of immobility with which the state started remains dominant, hence it is easily re-established when we wish to transform the state into one of *contention* for the purposes of autosuggestion.

There is one more mental state described by the author of *Suggestion et Autosuggestion*, which combines the characters of those already described. This is one in which hypnosis is produced by the fixation of the attention not on an external object, but on the idea which is to be the object of the suggestion. To this state he gives the name of *la concentration*. Notice that it is not the state of intense voluntary attention to which we generally give the name of " concentration." This is a fact of great importance for the successful practice of reflective autosuggestion. Dr. Baudouin defines it as follows : " a state of autohypnosis, and of persistent *contention* with one idea, the autohypnosis having been induced by the lulling influence of the idea on the mind." The simplest way of producing *la concentration* is to sum up the idea in a short phrase, and to repeat it over and over again, either aloud or sketching its pronunciation with lips and tongue.

An important practical question for autosuggestion is that of the formula in which the suggestions should be embodied. We will suppose that we are suffering from toothache and wish to autosuggest it away. If we use the formula " I want to be free from this," we shall find that this is too weak to be effective. If we go to the opposite extreme and say, " I have no toothache," our present experience of the toothache contradicts us. We shall find that we cannot accept the suggestion. This is the objection to the Christian Science formula, " There is no disease." Most of us are unable to accept a suggestion in this form because it contradicts our experience. This inability to accept a suggestion which does not harmonise with the knowledge we have obtained through our earlier experience is what is called in popular speech our " critical faculty." A suggestion in this form will be successful only with those whose critical faculty is abnormally undeveloped. For more ordinary people it is necessary to adopt some formula which is intermediate between these two extremes. The kind which has been found most generally useful is one which asserts that the undesired condition is growing better. In the case of toothache, we may use the form, " This is passing away." If we wish to use autosuggestion to help ourselves to sleep, we may use the formula,

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[1] I have retained the original French for Dr. Baudouin's technical terms, since their English equivalents suggest meanings remote from those intended.

"I am falling asleep." A detail insisted on by the New Nancy School is that the formula should be gabbled. This is to prevent the spontaneous autosuggestion contradicting the formula from arising in the mind between each repetition of it. For example, if when we are trying to go to sleep we repeat slowly, "I am falling asleep," it will be difficult to prevent the mind from thinking between each repetition, "I am not really, I am still as wide awake as ever." If this happens, the spontaneous autosuggestion of remaining awake will realise itself and defeat our efforts to realise the reflective autosuggestion of falling asleep.

The following are the uses of reflective autosuggestion. It can undo the evil work of noxious spontaneous autosuggestions, the illnesses which are the result of preoccupation with our health, and so on. It can be used for the cure of all functional disorders such as tics and hysterical paralyses or swellings. It is also of value in certain organic complaints. It can always help the natural process of cure, and it can undo the part played even in real organic disorders by spontaneous autosuggestion. Dr. Baudouin claims that it can cure pimples, warts, varicose ulcers, and eczema. It may also be used as a means of removing bad habits, and of obtaining complete control over sleep.

In the New Nancy School, it is not recommended that particular suggestions for the removal of specific troubles should be frequently repeated. After a trouble has been made the subject of a particular suggestion, it is claimed that it is sufficient to repeat about twenty times every night and morning the general formula: "Day by day, in all respects, I grow better and better." We are directed not to gabble this, but to repeat it piously, mentally underlining the worlds *in all respects*, and making them refer to all the troubles which it is desired to remove.

In this short space, it has only been possible to give the barest outline of a work of fascinating interest. The writer of this article will feel that his work has been of most value if it leads many readers to read Dr. Baudouin's book for themselves. It is absorbingly interesting, and its lucidity makes it an easy and a delightful book to read.

BOOKS RECOMMENDED

Suggestion et Autosuggestion, by Charles Baudouin. English translation by Eden and Cedar Paul. (Kegan Paul, Trench, Trubner & Co., Ltd., 15*s*.)

Instinct and the Unconscious, by Dr. W. H. R. Rivers. (Cambridge University Press, 16*s*.)

An Introduction to Social Psychology, by Professor W. McDougall. (Methuen & Co., Ltd., 8*s*. 6*d*.)

An Eighteenth-Century Character

By Rowlands Coldicott, M.C., B.Litt.

(Continued from the September number)

As a physician in orders, the future satirist of George the Third held during his Truro period a somewhat peculiar position. He dressed in black and wore ruffles, and was not particularly pleased to say grace when people asked him. The real object of his life during the eight or nine years that elapsed before his final departure for London was the accumulation of sufficient money to place him "beyond the caprice of a mob." To compass this end there is evidence that he lived with great parsimony in his own house, though his wit and verse and personality made him very frequently seen wherever amusement was toward. He shared in full the not unlively society of a West-country town in the last quarter of the eighteenth century. There were picnics and boating parties, dances on the green by moonlight, and much eating and drinking in neighbours' houses. This society and the excitement of local politics and scandals furnished Wolcot with plenty of material for eloquent epistles and virulent lampoons. The epistles, addressed to Sukey or Joyce Nankivell, Miss Dickenson or Betsy Giddy, were of this nature:

When sweet Cecilia[1] sought the skies,
  In tears were all the tuneful wits;
The fiddles poured chromatic sighs,
  And music had hysteric fits.

But, 'ere she vanished, thus she said:
  "A short farewell I mean to bid ye."
To keep her word the harmonious maid
  Appears in form of Betsy Giddy!

These were pleasant enough, but his lampoons gained him the ear not only of a few friends, but of all that local public. Most have disappeared, but four more than usually popular ones have survived in old books of reminiscence. These are, in order of composition, "The Dame of Fowey," "The Roast Pork of Old Truro," "A Christmas Carol," and "The Hall." The last was part of a combat between him and the Corporation; "measter auld cat," as the peasants called the doctor, had refused to take an apprentice, who, according to the custom of the time, were assigned to doctors by lot. The Corporation of Truro had been remarkably patient, but at last they became exasperated. Early in 1779 they commenced a prosecution against him, and Wolcot had to use all his social influence and pay over a hundred pounds before the matter blew over. Towards the end of that year one of the periodical drawings for apprentices took place, and Wolcot received this letter :

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[1] St. Cecilia, martyred at Rome about A.D. 280, became venerated later as the patron-saint of music, and in this connection many poets of the eighteenth century, including Dryden, Shadwell, Pope, and Addison, wrote odes for her day—November 22.

> TRURO November 28th, 1779
>
> SIR,
>
> I'm ordered by the Mayor and Deputy Recorder of this Borough, to acquaint you that there will be a regular Drawing for apprentices to-morrow morning by ten o'clock, at the Vestry Room, within the said Borough, when and where you are desired to show cause, if any, why you should not have an apprentice.
>
> JOHN BUCKLAND, *Overseer.*
>
> To Mr. Wolcot.

But, like a good general, Wolcot had anticipated this, and had decided to remove himself from their jurisdiction. He replied as follows :

> SIR,
>
> I have received your official note. Be so good as to present my most humble and respectful compliments to his Worship the Mayor, and also to the Deputy Recorder of this honorable Borough, and inform them that their blunderbusses have missed fire. You will let the Worshipfull Gentlemen know, *that* tho' I can by no means accept their *well meant favour*, I'm truly sensible of the *intended obligation*. As my house is taken by another tenant, the furniture except a few immaterial articles removed to Helston, and the servant discharged, I'm tolerably certain that I do not come within the description of a person entitled to that *good fortune*. I must therefore desire them to transfer their favour to some dearer friend. Should they, however, through *violence of affection* insist on placing an apprentice on the House (for the Mayor and Deputy Recorder of the *honorable* and *independent* Borough of Truro are almost *omnipotent*) be so good, Mr. Buckland ! to attend the aforesaid gentlemen to my door with the apprentice, and desire them to thrust him through the key-hole.
>
> WOLCOT.
>
> To Mr. John Buckland, Overseer of the honorable and independent Borough of Truro.

If this were all, it is doubtful if Wolcot would have come to London or have become famous. But about four years before this an incident happened which changed the whole course of his life. And this, it is pleasant to observe, came about not through self-seeking, but by doing someone a good turn.

The Nankivells, including Sukey and Joyce, lived at Mithian, in the parish of St. Agnes, some eight miles from Truro, and Wolcot often used to ride over to see them. One day Wolcot was criticising a print that hung in the parlour ; " a busy scene," he said, " but ill executed," whereupon one of the Miss Nankivells rejoined that " it was greatly admired by many, and particularly by John Opie, a lad of great genius." Wolcot went off at once in search of the boy, and found him working in a saw-pit. He asked him if he could paint, and the boy ran off to get his productions. " I shall always hear," said Wolcot, years afterwards, " the sound of the boy's leather apron clattering between his knees." The relationship between the two soon developed into that of master and pupil, and before long Opie came to live with Wolcot at Truro. Here in the midst of his doctoring and quarrellings and dinings-out he found time to teach all he knew of painting and drawing to the enthusiastic lad, throwing in also instruction in French and Latin. Opie was a mere boy, but before long he was tramping the district, with no lack of orders from county families. When the final disturbance took place between Wolcot and the Corporation of Truro, Opie moved with him to Helston. In 1780 one of Opie's pictures was exhibited in London at the Society of Artists. About this time Wolcot got into correspondence with a Mrs. Boscawen, who held a distinct position in London society. It seems to have been in the month of December, 1781, that Wolcot and Opie cut themselves adrift from the West Country and tried London as a field for fame and fortune. They made a compact : the earnings of both were to be pooled and halved.

The success of Opie, though he paid for it later by loss of popular favour, was immediate and complete ; Mrs. Boscawen took him to Mrs. Delany ; an audience of the king followed. Wolcot played his part assiduously and well, calling several times on Sir Joshua Reynolds with Opie's pictures. Reynolds was impressed, and compared him to Caravaggio. The king, careful as always in matters that involved money, smiled and spent a little. Two letters, the first written by Wolcot to a friend at St. Agnes, the second by Opie himself, best describe the situation, and show how piquant the rustic painter must have been to London society.

> [*Undated, probably February* 1782]
>
> I have at length got Jan introduced to the King and Queen. The night before he went, I was employed in teaching him how to make King and Queen bows ; to keep his hands out of his breeches pockets, and blow his nose before he got into Buckingham House ; in enjoining him, not to make a comb of his fingers, and scratch his pate with his claws, on the approach of their Majesties ; in insisting on his not spitting about the carpet, and twirling his hat upon his thumb. All this Jan promised to observe faithfully. As he was carrying his pictures into the room of the Palace, Jan was followed by the Queen, who treated him with great kindness, so much indeed, that he is now turned Quixote, and is ready to fight up to the knees in blood, for her Majesty. The King came in after ; with a skip (not a very proper pace I think for Majesty). West was with him, I mean West the famous painter, a monstrous favourite of George's. George asked Jan a number of questions, which (from Jan's history of himself after his return) he answered with a St. Agnes intrepidity. The Pictures were placed in order, and the British Monarch applauded the Artist ; the Queen turned up the whites of her eyes marvelling ; the little princes lisped praises, and Jan, to be sure, was in an ecstacy. He remained nearly an hour and half with them, and then took his leave. The pictures he carried were : An Old Jew, A

Beggar and his Dog, the Old Kneebone of Helston, and Mat. Trevenen. The Beggar and his Dog the King kept, as well as the portrait of a lady, which Jan painted expressly for him. West was ordered to give Jan the money, and to say that he (George the Third) wished him every success. On Wednesday the boy paints the Duke and Duchess of Glos'ter, and I suppose the children. He waited on them a few days since, and was graciously received by their Royal Highnesses. He is now painting the most beautiful women of the Court, Lady Salisbury, Lady Charlotte Talbot, Lady Harcourt, etc. You cannot think what repute Jan is come into; I told you before I got him introduced; indeed I did, for by recommending him to Mrs. Boscawen's patronage, she made it a point, to oblige me, and immediately introduced him to Lord and Lady Bute, the Hon. Mrs. Walsingham, Lord and Lady Mount Edgecombe, Mrs. Delany, a chief favourite of their Majesties, etc., etc., who, showing her picture done by him, to the King, he was immediately sent for. Now he is established, it will be his own fault if he does not make his fortune.

Opie to his friends in Cornwall

[*Undated, probably same month*]

My dear Friends,

I must ask you ten thousand pardons for neglecting to write you all this while. I shall never forget the obligations I am under to Mr. Penwarne and his family.

I think I am fixed here for the winter; however, whether I will or no, and the only thing I regret is that I cannot see you sometimes; I wish, indeed, I expected to see one of you here before now.

I have been exceedingly lucky since I have been here, I have all the quality at my lodgings every day, nothing but Lords, Ladies, Dukes, Duchesses, etc. I was introduced to Sir Josh. who said many handsome things of me both to my face and behind my back.

But—Loard—I've 'a zee'd the King and Queen, and was with them at the Queen's house and taalked wi'mun two hours and painted vor mun the picture of an old lady and a blind beggar and dog. I am not yet paid for 'em.

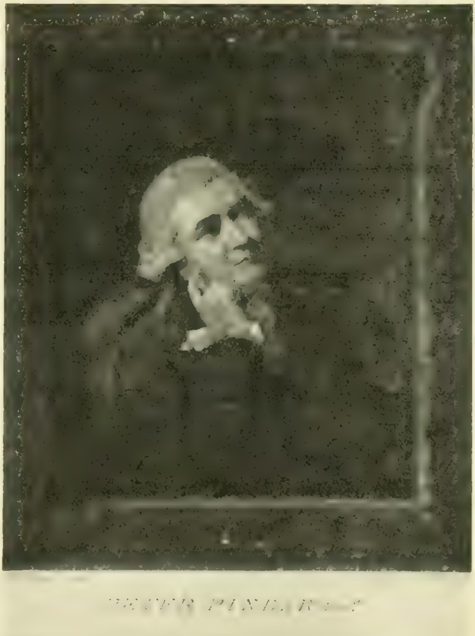
West was there at the same time. After the King went out, West asked me the price of the pictures, and said the King wished to be considered as a private gentleman. I had a great mind to ask if the King paid him as a private gentleman. . . . Can I be of any service to you? Any commands that you may have I will gladly execute. If you want anything that I can get for you, be so good as to mention and it shall be done. I hope to have the pleasure of hearing from you soon. Please to give my best respects to Miss Lawrence and Miss Penwarne and Mr. Penwarne, and shall be glad to hear that they are well.

Gentlemen,
I am most sincerely
Yours,
J. Opie.

Please to direct to me at
Mr. Riccard's, Orange Court, Castle Street,
Leicester Fields,
London.

It is worth noting that in Opie's letter there is no mention of Wolcot. The success of the young man had already placed a heavy strain upon the compact of the two to divide profits. It is not known that Wolcot published anything during these first London adventures—probably he was much too busy exhibiting Opie. But though he was still able—probably because the youth was totally absorbed in painting—to show him about in an uncouth state, his long hair about his shoulders, he could not teach him to be careful with his public. Opie cared in the first place for art, Wolcot for the influence and reputation he expected it to bring. The two men's ideals were dissimilar: by bringing Opie to London, Wolcot had already in effect dissolved partnership.

Curiously enough it was through his attention to the fortunes of Opie that his chance came. Wolcot did not recommence authorship in order to "puff Opie in the Press" as some writers have stated. His first production contains no reference to the "Cornish Wonder," and though he hailed him on a subsequent occasion, it was only in passing. But the artist was nevertheless the remote cause of his choice of subject. Wolcot had throughout his life kept in touch with painting, had himself practised the art, and is even said to have studied at some period of his life under Richard Wilson the landscape painter, whose style he imitated. During his residence at Truro he had corresponded with Northcote, and on Ozias Humphrey's return to England in '77 had greeted him with verses. He was probably well known at the time to other artists. On his arrival



MEZZOTINT PORTRAIT OF DR. WOLCOT BY OPIE 1787.

with Opie at Leicester Fields, he passed into the heart of artistic London. By 1782 a public had come together that was willing to patronise art—or at all events to talk about it. The Academy, aided by a few honest pushes from George III., had become fashionable. Twelve years before this date Horace Walpole had noted with some dismay that prices were on the rise. "One West," he says, "gets £300 for a piece not too large to hang over a chimney." The Royal Academy, with Reynolds as its presiding genius, was now in its fourteenth year. Gainsborough, though in the last years of his life, was still in the height of his reputation. Reynolds had not yet ceased producing, and was attracting numerous imitators. West, the chief recipient of the King's bounty, had seen the absurdity of representing modern English gentlemen in Grecian costume. Art was breaking fresh ground in every direction. Nor were younger men wanting to carry on the flame. George Morland was now on the threshold of his career. Caricature had just reawakened at the touch of Gillray. Rowlandson, who could rival Morland in his own line, turned his attention to it some two years later. A flock of foreigners—"the exotic R.A.'s," Wolcot called them—had come over to England, attracted by the opportunities afforded by the Royal Academy, and some had been received into the body of that institution.

In the general glamour that hung over this varied mass of excellence, it was not easy for the average man to distinguish the light of polished mirrors from the unique and primitive flame. One could hardly go wrong in praising Reynolds, but on the hundred and one other men of varying merit the general public was incapable of passing any intelligent verdict. The artists themselves had set up a certain standard, but the talk of studios is not what the world understands by criticism. The business of painters is to paint; and though an artist may lay aside his tools for a moment and deliver dicta, criticism must ultimately come from outside. Of this independent judgment the public had practically nothing. In 1781, a creature who called himself "The Earwig"[1] had made some abortive remarks in prose on that year's Exhibition. His pamphlet is neither witty, nor instructive, nor entertaining. A strong fearless critic is always welcomed; Wolcot was the one man competent to step forward and take the office. In the *Critical Review* for July 1782, amongst the long, uninteresting lists of minor publications that the magazines of the late eighteenth century were wont to print in their "Monthly Catalogues," appears the notice of a pamphlet entitled "*Lyric Odes to the Royal Academicians*, by Peter Pindar, a distant Relation to the Poet of Thebes." The size was quarto, the publisher one "Egerton," and the price a modest sixpence. The reviewers at once separated it from the throng, and bestowed on it nearly a page of quotation and comment. They little knew that they were encouraging an author whose pamphlets would besiege their pages for over thirty years, until expectation lost its thrill, and criticism itself was tired out.

(*To be continued*)

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[1] The Earwig, or an Old Woman's remarks on the Present Exhibition of pictures of the Royal Academy, etc., etc. Dedicated to Sir Joshua Reynolds. Printed by G. Kearsley, 1781.

At the British Association's Meeting

MEMBERS heard with regret that the proposal of last year to fit out a British oceanographical expedition, like the *Challenger* expedition of the seventies, is postponed indefinitely, because the time is unsuitable for an appeal to the Government or the public for the large sum of money necessary.

The prevailing note of most speeches was a cheery optimism. Science was indicating on every hand that she would do great things for man if only he would take himself in hand so that he might use her fruits aright. Several speakers pointed out how important such subjects as Organic Chemistry, Anthropology, Geography, and Physiology had become of late, and how necessary to mankind was the knowledge they furnished. It followed that increased facilities for teaching, and carrying out research in them should be granted to colleges and schools. Dr. M. O. Forster, in the Chemistry Section, after giving a highly technical survey of recent work on the vegetable alkaloids, the nucleic acids, chlorophyll, and the pigments of blossoms and fruits, pressed for more teaching on organic chemistry. He pointed out that, with the exception of air and water, the important things in life were organic—shelter, clothes, food ("baby's milk and grandpapa's Glaxo"). Yet many grew to manhood without "the slightest real understanding of their bodily processes and composition, of the wizardry by which living things contribute to their nourishment and to their æsthetic enjoyment of life." Sir Richard Temple in opening a discussion on the need for an Imperial School of Anthropology pointed out that officials, missionaries, and others intending to take up work among people in the East needed, besides an acquaintance of the language, a knowledge of the racial characteristics of the people whom they sought to serve. The need of the races of Europe for a proper understanding of non-European races could best be met in the British Empire by the establishment in London of a central body to organise a system of training, which could be done at the universities in Great Britain and throughout the Empire. Pleas for a wider study of geography and physiology and for bringing these sciences more into touch with national life were made by Dr. D. G. Hogarth and Sir Walter Fletcher respectively.

Below are given résumés of some of the sectional addresses and discussions likely to be of interest to readers.

THE AGE OF THE EARTH

There are three main points of view: the physical, the astronomical, and the geological. In Victorian days Lord Kelvin startled the world by calculating that the greatest time for which the earth could have been habitable was twenty million years. He based this theory on two ideas: (1) that the earth was losing its primitive heat, like a hot loaf taken from the oven, at a rate which could be calculated, and (2) that the heat radiated by the sun was due to energy produced by its contraction.

Lord Rayleigh, who opened the discussion, pointed out that present-day knowledge of physics extended the period of life on the globe to 1,000 million years, and that the total age of the earth was probably a few times this amount. The earth was not cooling like a hot loaf. It had a supply of heat of its own within it, namely that emitted continuously, spontaneously, and apparently always at the same rate, by the radio-active elements (uranium, thorium, radium, etc.). It was fortunately possible to calculate the age of the rocks which contained these elements, and the Eocene rocks were estimated to be about 30 million years old, and the oldest known rocks 952 million years!

Professor Sollas put forward the geological view. Geologists considered Lord Kelvin's estimate much too low, Lord Rayleigh's much too high. He pointed out that if radio-active bodies originally emitted energy more rapidly than they now do—and there is some evidence of this—Lord Rayleigh's might be reduced. Professor Gregory pointed out that the geological estimate was based on the time required for the deposition of geological formations. The rate at which this went on was assumed to be uniform, but probably periods of slow and quick denudation had occurred in consequence of deformations of the earth, and allowance for these would bring the geological estimate nearer Lord Rayleigh's. Professor Eddington said that present-day astronomy was against Kelvin's time-limit, also against his attributing the sun's heat to its contraction.

PROBLEMS OF PHYSICS

Prof. O. W. Richardson's address considered the present state of some of the important problems of physics: the theory of Relativity, the quantum theory, the structure of the atom, the emission of ions from incandescent bodies, the close connection between the phenomena of light and of X-rays. It was, for the most part, extremely technical. Artificial transformation was now an accomplished fact, though it had been effected so far only on an extremely small scale. The transformed element was not merely changed into others, but the energy liberated when this occurred was greater than that necessary to initiate the process. This energy was very small, but it was enormous in comparison with the quantity of matter involved. A start had been made; if these effects could be intensified and yet be kept under control, an almost illimitable supply of energy was at man's disposal. It was yet too early to say whether or not the conditions for producing this energy on a large scale under control could be realised in practice. Time would tell. We might be at the beginning of a new age which would be referred to as the *age of sub-atomic power*.

Professor A. S. Eddington gave an illuminating account of Relativity, mentioning that the theory made the ether an idle hypothesis unsupported by experiment and giving explanations of nothing. Sir Oliver Lodge said that an exponent of relativity was so immersed in this subject that he thought it self-evident. He was like the cricketer who, being asked to explain a yorker, replied that it was just a "yorker." Sir Oliver was not prepared to abandon the ether.

VOCATIONAL TRAINING AND TESTS

Members of the Sections for Psychology, Education, and Economics took part. Dr. C. W. Kimmins opened the discussion. Psychology was permeating everything and becoming embarrassingly popular. Intelligence tests were being used in connection with the admission of defective children into special schools. London, with 800,000 children and 20,000 teachers under one authority, was the finest field in the world for research on this subject. In the old days backward children were sent to special schools without the cause of their backwardness being considered. Now they could tell by intelligence tests whether or not a child had ability apart from the knowledge he had gained. These tests had also been of assistance in transferring pupils to the classes in schools which really suited their abilities. In some cases unlikely pupils in the wrong classes had on transference blossomed into scholarship winners. As regards vocational tests, a recent investigation of his into the after-employment of children in the London area had revealed a tragic state of things. Large numbers of children started work in jobs that were unsuitable to them, and later drifted from one position to another. There were too many misfits; boys of promise became van-boys! The money that we were spending on education would be thrown away unless greater attention were paid to fitting the right boy, as far as it was possible, into the right job.

Dr. C. S. Myers said that a child was badly educated unless he showed special interests or abilities of some kind. A choice of occupation must be made by the boy himself, and he should not be bullied out of it. But naturally information about different occupations must be given him. There should be cinematograph films showing the responsibilities, prospects, advantages, and dangers of various occupations. Neither parent nor teacher could give adequate advice on occupations, because they knew little of industrial requirements. Expert advice and the teacher's co-operation were necessary.

Subsequent speakers talked much of the misery and unhappiness arising from mistaken choice of occupation—

'the round peg in the square hole.' But it was ultimately agreed that workers were neither round nor square, but, being malleable, had in time to adapt themselves to fit into either the round or the square position.

PREFERENCE OF SUBJECTS IN THE SCHOOL CURRICULUM

Mr. J. Don opened an interesting discussion on the preference of pupils for certain subjects of study. About 3,000 pupils of intermediate classes of 93 schools in the West of Scotland were asked to write down the order in which they liked the subjects—English, French, Mathematics, Science, and Drawing. Answers came from 1,855 boys and 1,760 girls. The boys' order of preference was science, English, drawing, mathematics, French; the girls' order was English and French at the top, science and mathematics at the bottom. No definite reason for the boys' indifference to French or of the girls' indifference to science was given. The high place occupied by English in both lists is ascribed to the excellent way (through literature) in which this subject is taught in Scotland.

MUSIC IN EDUCATION

Sir Henry Hadow (Vice-Chancellor of Sheffield University) opened the discussion. He urged that music should be given a place in the curricula of schools and colleges. It was not everybody's subject, but the whole school night well take part in class singing, and listen to an occasional lecture or concert, while those with an aptitude for it might take it instead of some other subject. Taught properly the study of a great composer might be educationally as good as that of a great poet. A syllabus for music could be drawn up to fit into existing curricula without encouraging faddists, excusing idlers, or producing the class that talk emotionally about music without understanding it. Pupils should be encouraged to read good music with the approximate facility of reading a book. Every public library, and, if possible, every school and University library, should contain a musical department which included the standard classical compositions and the first-rate books on musical æsthetics and criticism. The speaker pointed out that the public put up with a standard of music which they would not tolerate in other things. Ninety per cent. of the stuff written on music-paper was not music. A band would submit a programme for a concert which to an intelligent musician was nothing but an insult, and naïvely reply when reproached that they were not aware that first-class music was wanted.

The story with which Sir Henry started his address is worthy of repetition: "Some years ago we were sitting round the fire in an Oxford Common Room. The Dean, who had the evening paper, let his eye fall upon a paragraph of musical criticism, and read it aloud in that tone of polished irony which we all knew to be his accustomed mark of disapproval. It was a harmless paragraph, and contained somewhere an innocent technicality—I think 'sub-mediant.' When he had finished, he looked across to the eminent scholar by the fireside and said, 'Of course, you know what a "sub-mediant" is?' To which came the answer, slow, meditating and pious, 'God forbid.'"

Reviews of Books

The Origin and Evolution of the Human Race. By ALBERT CHURCHWARD, M.D., M.R.C.P. (Geo. Allen & Unwin, 45*s.*)

This book is a queer jumble of anthropology, archæology, a little heterodox astronomy, a few knocks at socialism, and personal attacks on several of our distinguished exponents of the pre-history of mankind. Its purpose is to set forth as completely as possible the evolution of mankind. The author's main point is that man arose not in Asia but in the Valley of the Nile, and he attempts to substantiate this and trace man's spread over the earth, both by examining the archæological evidence which throws light on his various cults, and by considering the so-called savage and backward races, which exist to-day, from many points of view. He feels pretty sure that his conjectures on the origin of man "are true and irrefutable," but, although a reviewer may consider the first of these adjectives too optimistic, it is highly certain from the manner in which the book has been written that it will not be refuted. That would be unnecessary.

The book contains many wild statements that the reviewer feels have been made, not because they represent an assertion that is genuinely felt to be true, but because they fit in with the mood of their utterer and merely express personal dislikes. Dr. Churchward's views on what was happening on the earth six hundred years ago are necessarily speculative, but one may judge approximately of his right to speculate with some measure of probability by what he says of events occurring in historical times that we all know about. Yet here he is very wild, and his descriptions of the Greeks, the Egyptians, and the spread of Christianity are somnambulistic. From these a reader may safely judge the whole book.

It is difficult to see for which class of reader the book has been written. It is too long and too dear for the ordinary reader, too difficult for the man specially interested in anthropology, and too untrustworthy and unscientific for the expert.

A. S. R.

Relativity and the Universe. By DR. HARRY SCHMIDT. Trans. by DR. KARL WICHMANN. (Methuen, 5*s.*)

The Fourth Dimension Simply Explained. Edited by HENRY P. MANNING. (Methuen, 7*s.* 6*d.*)

The first of these books is the outcome of a series of tutorial lectures on relativity delivered to an educated but not *specialised* audience in a town on the Elbe. It is a fuller and perhaps simpler exposition than that contained in Einstein's own book, with a wealth of analogies and much colloquial expression. It contains no mathematics. It is nevertheless not a book for everybody, but a reader with a groundwork of elementary physics and mechanics will find it useful and reliable.

The second, alas! is rather behind the times. It consists of the best essays of a popular nature on the subject of the Fourth Dimension submitted in a competition in the *Scientific American* in the year 1909. The trouble here is twofold. The interest in the hypothetical fourth dimension, in which knots can be magically untied and left-hand gloves fitted on the right without difficulty, is not now what once it was. Since 1909 Einstein and others have helped to give us a real world of four dimensions which is unlike the old hypothetical one, and therein lies present-day interest. Secondly, many of the statements in this book are *burst up*, as they say, by the theory of relativity, and it is questionable if the publication of these essays in their original form was wise.

A. S. R.

The Oxford Outlook. January, March, May, and June numbers. (For the Proprietors by the Oxford Chronicle Co., Ltd., in conjunction with Basil Blackwell.)

One of the most interesting developments in post-war university life at Oxford and Cambridge has been the great increase in undergraduate journalism. In many ways *The Oxford Outlook* is the most noteworthy as it is also the most ambitious of the Oxford undergraduate publications. Started by ex-service students as far back as 1919, it is now edited by Messrs. L. P. Hartley and Basil Murray, and is published monthly during term-time. It is a literary review, which does not attempt to bow down to the lowest level of undergraduate intelligence, but sets out to publish the creative work in prose and poetry and the literary criticism of the best young minds at the university. Its contributions are, as is to be expected, somewhat uneven in value, though many of our better-known young writers have appeared in it lately, including Robert Nichols and Edmund Blunden. To those who are interested in the serious and progressive side of Oxford undergraduate life and thought, this journal is recommended.

E. L.

Travels of a Consular Officer in North-West China. By Eric Teichman, C.I.E., B.A. (Cambridge University Press, 25*s.*)

Books of travel are generally of two types, descriptive or informative. Globe-trotters and journalists usually try their hand at the informative type, government officials and resident press correspondents at the descriptive. The books of both parties, it need hardly be added, are failures in nine cases out of ten. This book is not a failure. It is written by a member of our Consular Service in China, who sets out with the definite object of conveying to the reader the information of an expert on his subject—which in this case comprises present-day conditions in the north-western Chinese provinces of Shenshi and Kansu. These provinces merge, on their north-western fringes, into the vast and arid *gobi* of southern Mongolia, but, unlike their neighbouring territory, they possess great potentialities of mineral and agricultural wealth. Indeed, one of the most interesting chapters, that on railway projects, leaves one with the impression of how great a quantity of material is waiting to be thus freed to the world.

Mr. Teichman's knowledge is based on a series of journeys that he has made through Shensi and Kansu in connection with the Anglo-Chinese Opium Treaty and other Anglo-Chinese investigations. In all he covered a distance of 4,000 miles. Particularly interesting is the account of his journey from T'Aochou to Labrang Monastery on the north-eastern borders of Tibet, and of the peculiar types of peoples, Tibetan nomads and Mahomedan and Christian missionaries, that he encountered during it.

We do not recommend this book to those who expect to read of "soaring peaks," "limitless deserts," or "valleys carpeted with flowers," but we do recommend it to serious students of geography or anthropology.

E. L.

The Depths of the Soul. By Dr. W. Stekel. (Kegan Paul, Trench, Trübner & Co., Ltd., 6*s.* 6*d.*) (For further details see under "Books Received.")

This book of short studies by a well-known Austrian psycho-analyst has suffered to some extent in the translation to another language. Dr. Stekel is rather apt, like many other psycho-analysts, to over-accentuate single motives as the mainsprings of our desires and actions; but he is obviously a fine writer of prose (a fact which can easily be realised despite some of the blemishes of translation), and he has here shown us the literary possibilities of his science. In this book we see him as a creative writer making use of his valuable special knowledge. As such he would have acted more wisely in dropping all technical language, but the intrusion of coldly scientific words does not, fortunately, hide the intensity of feeling and the power of revelation that Dr. Stekel undoubtedly possesses.

Our fancy was particularly taken by *Eating*, over-indulgence in which the author ascribes, with, it must be said, a rather unconscious humour, to a displacement of the sex impulse, *Those Who Stand Outside*, in which he shows the inner sadness of a physician's life; and *All-Souls*. In the last study he finely expresses the transiency of early friendships. He describes the failure of a joint expedition that he took with one who several years before had been his most devoted friend and whose friendship he had wished to renew, and he sums up the reason for the failure in these words: "Was that anything wonderful? Years had passed. Each one of us had experienced thousands of impressions, and what had once been common and had borne the same image had become so different that it would have been impossible to recognise them as having had a common origin. And thus it is that we stand on the roads that once were so near each other but now are so wide apart, and that we call to each other like frightened children seeking flowers in the woods and longing anxiously to hear the voices of their comrades. We call to each other to prove to ourselves that we have not died."

E. L.

Books Received

(Books mentioned in this column may or may not be reviewed in this number, or in a later number.)

HISTORY

A Constructive Notebook of English History. By E. H. DANCE, M.A. (Basil Blackwell, 3*s.* 6*d.*)

A useful book to schoolmasters in preparing notes for history courses, and to advanced students. It is a skeleton-outline of British history from prehistoric times to the present day, and it indicates possible subjects and lines of study, supplementing them with valuable bibliographies.

MISCELLANEOUS

The Heart of Nature, or the Quest for Natural Beauty. By SIR FRANCIS YOUNGHUSBAND, K.C.S.I., K.C.I.E. (John Murray, 12*s.*)

Twenty-five Years in East Africa. By JOHN ROSCOE. (Cambridge University Press, 25*s.*)

PSYCHOLOGY AND PSYCHO-ANALYSIS

The Depths of the Soul. Psycho-Analytical Studies. By DR. WILLIAM STEKEL. Authorised Translation by DR. A. S. TANNENBAUM. (Kegan Paul, Trench, Trübner & Co., Ltd., 6*s.* 6*d.*)

The Gain of Personality. A Popular Psychological Statement of the Practical Values of Personality. By W. CHARLES LOOSMORE, M.A. (John Murray, 6*s.*)

This book should prove welcome to those who, afraid of the subtle theories of psycho-analysis, would rather commit themselves to a more apparently obvious and practical exposition of "how to make the best of your character."

APPLIED SCIENCE

Fuel and Refractory Materials. By A. HUMBOLDT SEXTON, F.I.C., F.C.S. New edition revised and enlarged by DR. W. B. DAVIDSON. (Blackie & Son, Ltd., 12*s.* 6*d.*)

Hydro-Electric Engineering. Vol. I: "Civil and Mechanical." Editor, DR. A. H. GIBSON; Contributors, H. D. COOK and EDITOR. (Blackie & Son, Ltd., 25*s.*)

Chemical Technology and Analysis of Oils, Fats, and Waxes. By DR. J. LEWKOWITSCH, M.A., F.I.C. Sixth edition. Edited by GEORGE H. WARBURTON. In three volumes. Vol. I, 36*s.* net; Vols. II and III in the press. (Macmillan & Co., Ltd., 36*s.* net.)

Introduction to Textile Chemistry. By H. HARPER, B.Sc., etc. (Macmillan & Co., Ltd., 3*s.* 6*d.*)

A History of Aeronautics. By E. C. VIVIAN and W. LOCKWOOD MARSH. (Collins, 30*s.*)

The history of aeronautics, which has developed so amazingly in the lifetime of all of us, has now been set down within the compass of a single volume. The authors give a detailed account of how the aeroplane, the balloon, and the dirigible of to-day came into being, and trace their development until August of last year. Part I deals with the aeroplane, and an idea of the treatment may best be given by mentioning the titles of some of the chapters: Lilienthal and Pilcher; American Gliding Experiments; S. P. Langley; The Wright Brothers; First Fliers in England; Rheims, and After; the Channel Crossing; London to Manchester; the War Period; 1919–20. Part II deals with progress in design, and is contributed by Col. Lockwood Marsh. Part III deals with dirigibles, the commercial airship, and balloons. Part IV deals with engine development. The compilation of all this matter has been judiciously and carefully carried out, and a good book is the result. Its value is increased by the variety and number of the illustrations. It will bring back to readers pleasant recollections of pre-war years, and some of the few pleasant ones of war-time.

SCIENCE

The Fourth Dimension Simply Explained. Edited by HENRY P. MANNING, Ph.D. (Methuen & Co., Ltd., 7*s.* 6*d.*)

An Introduction to the Theory of Relativity. By LYNDON BOLTON, M.A. (Methuen, 5*s.*)

Entropy as a Tangible Conception. By ENG. LIEUT.-COMMANDER S. G. WHEELER, R.N. (Crosby, Lockwood & Son, 8*s.* 6*d.*)

The Physical Properties of Colloidal Solutions. By E. F. BURTON. Second edition. (Longmans, Green & Co., Ltd., 12*s.* 6*d.*)

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Strasburger's Textbook of Botany. Rewritten by PROFS. FITTING, JOST, SCHENCK, and KARSTEN. 5th English edition, revised with 14th German edition by PROF. W. H. LANG. 833 illustrations. (Macmillan & Co., Ltd., 31*s.* 6*d.*)

On Certain Fundamental Principles of Scientific Inquiry. By DR. DOROTHY WRINCH and DR. HAROLD JEFFREYS. (Reprinted from the *Philosophical Magazine*, vol. xl i, Sept. 1921.)

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Editorial Notes

During the last few weeks public interest has in various ways been directed to questions concerning the development of national and international communications. A prophetic speech, mostly relating to air communications, was delivered by our Director of Civil Aviation, Major-General Sir Frederick Sykes, at the annual dinner of the Institute of Transport on October 10; Lord Curzon gave expression during the last Parliamentary session to what we believe is a steadily growing popular wish—the desire for the Channel railway tunnel; the Richborough Ferry, first employed for war purposes, has recently been found of great use in the transport of fruit trains, coming from the south of France, across the Channel; the French Press, prompted by the present state of affairs in Morocco, has been discussing the possibilities of a railway tunnel under the Straits of Gibraltar, for which a not too ambitious scheme providing for a single tube 18 feet in diameter has been drawn up by the well-known Spanish engineer, Señor Rubio y Bellue; as to ventures less far afield and of more local importance, the London Traffic Combine has submitted a scheme to the Government for extending the London underground railways in connection with the Government's proposal of guaranteeing the interest on capital issues to be used for undertakings likely to provide work for the unemployed.

Objections raised against launching out on new projects of this kind at a time when the whole of Europe and even America is struggling in the grip of a financial *chimæra* seem plausible enough at first sight. But very strong arguments exist against such objections. It is, for instance, questionable whether we can afford in the long run to stay the material progress of our civilisation. As Sir Frederick Sykes said in the speech which we have mentioned, "The evolution of our civilisation is largely a history of endeavour to extend the limits imposed upon human living and mobility in each of the great phases through which it has passed." He also remarked that "foresight of a few years is not too much to ask when it is a question of the advance or decline of our Empire, and yet nobody seems to have time to think more than a week ahead." We hold no particular brief for international competition; we would rather see international co-operation in such matters, though naturally we desire our Empire to take a prominent part in such co-operation. The last few years have taught us two lessons—that nations are to an enormous extent dependent for existence one upon another, and that for this reason the development of communications between them is essential. If the machinery of our civilisation is creaking at present, the best way to rectify the evil is to increase the plant and so alleviate the stress on the existing mechanism.

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Another and more immediate argument for hastening into actuality recent discoveries and developments in air and land transport is that this would provide work for thousands of our unemployed. The Government has proposed backing commercial enterprises with credit to the extent of £26,000,000. It was made clear in an article in last month's Discovery[1] that such action can only be in the nature of a palliative. Palliatives have, however, become a necessity, as Professor Knoop indicated, and palliatives that can be applied to such sound uses will prove most valuable. It is obvious that the development of aerial highways throughout our own Empire will in the long run be attended by the most far-reaching results of any means of communica-

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[1] *The Problem of Unemployment*, by Professor Douglas Knoop, p. 286.

[illegible] of the Government's [illegible] heavily subsidising goods and passenger traffic by air, and we are inclined to think that the country's proposed credit would be more valuably devoted to railway extensions. The schemes submitted by the London Traffic Combine for the extension of our capital's underground railways should prove a great benefit when put into operation, but, as we have noted, they are of almost entirely local importance. The electrification of our railways, plans for which were proposed by Sir Eric Geddes some time ago, would serve eventually as a fillip to our home trade. Yet it seems to us that the linking-up of our railways, by a Channel tunnel, with those of the Continent would have a far greater effect upon our national prosperity than any other single scheme, vastly promoting, as it would, our import and export trades.

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For such a project we have the men, the material, and, we hope, a willingness on the part of the Government to back it with a portion of the proposed credit for commercial enterprises. Is any capitalist or any body of capitalists willing to come forward with the money? The time is not by any means inopportune to urge once more that at least a start might be made with the project. The objections are that the risk is great and that no return upon such an investment is possible under at least ten years. Engineers, however, have told us that the project is a practicable one, and it is certain that the eventual financial return would be enormous. The idea that the tunnel would destroy Great Britain's position as an island and render her more liable to attack during war is now surely negligible. We are already part of Europe, and in the next great war the menace, for example, of air attacks will a thousand times outweigh that of one through a couple of tubes no wider than the funnels of a big liner and capable of being blocked with the greatest ease, especially if the suggestion formerly in favour were adopted, of exposing a stretch of the approach to the tunnel to naval fire by putting the line on the front of the cliffs.

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One is naturally tempted to consider the more distant possibilities brought within our reach by twenty-five miles or so of tubing. London, for instance, would be placed in direct railway communication with far eastern Europe, with Bukarest, Constantinople, and Athens, not to mention all the capitals of Western Europe. During the war the Germans, by cutting through the Taurus mountains in Asia Minor, connected Constantinople by railway with Aleppo and Nisibin, while the British connected Cairo with Jaffa and Jerusalem, and in Mesopotamia built a line from Basra to Tekrit. With some readjustment of the lines in Palestine and southern Syria, the laying out of some two hundred miles of permanent way to connect Tekrit and Nisibin on the northern frontier of Mesopotamia, and a settlement of the present Græco-Turkish war, Constantinople could be put into railway communication with Cairo, and with Baghdad and Basra. Despite conflicting interests, we expect that all these things will have been done by the time the Channel tunnel is finished, and we shall be able to travel by train from London to Cairo and Baghdad. It is just possible, too, that within the next ten years the Cape to Cairo line may take material shape, though it has to be laid through very formidable natural obstacles; while an alternative route from London to the Cape would be opened up by the Gibraltar tunnel scheme, and the extension of the railways along the northern coasts of Africa.

But it will be said these are merely romantic speculations. The great value of the tunnel would lie in the elimination of loading and unloading at Channel ports, and the immense resultant speeding up of freight between London or the manufacturing towns of this country and the capitals and manufacturing towns of Europe.

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We are glad to see that someone[1] has at last expressed a reasonable attitude towards Psycho-analysis. Thanks largely to its successful application to shell-shock cases, it took the public by storm towards the end of the war and thereafter, though it had been widely practised and discussed in central and southern Europe for ten years before the war. Other reasons for its popularity were that it was an easy science for the layman to understand, and the charlatan to exploit, it explained one's individual foibles in a pleasant way, and it allowed a more open discussion of sexual questions than had hitherto been considered "proper." Of course the Press took it up with gusto, and by making *copy* out of the extremists' theories did great harm to the reputation of the science. A reaction, largely developed in the correspondence columns of the daily Press, set in, and abuse was hurled at the whole school of our psycho-analysts by sceptical doctors and other persons who had been led to believe that the new science consisted of the frankly sexual and materialistic interpretations of Freud's more extreme followers, and that in the hands of charlatans it was undermining our national morality.

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It is true, as the editor of *Psyche* admits, that "some of Freud's followers, as is the custom of disciples, have carried certain of his views further and have stated them more dogmatically than he himself would care to do, and there can be little doubt that he himself has unnecessarily alienated the sympathy of many students

[1] The editor of *Psyche* in the Editorial of the October number.

by his occasionally unfortunate use of words, notably the term Sexuality, which he has used to include all kinds of things which are only very remotely connected with sex as commonly understood." It is true also that the patiently worked out results of experienced practitioners were and are being exploited by charlatans. What, however, may well be emphasised is the fact that psycho-analysis, in the hands of the more moderate schools of Jung and Adler, is being developed into a science of inestimable value to mankind, that these schools should not be confused with the extreme Freudians, and that specially qualified practitioners in psycho-analysis should not be condemned together with charlatans.

* * * * *

On these points we are thoroughly in agreement with the editor of *Psyche.* But we are not quite so sure if we agree with him in his suggestions as to persons qualified to undertake psycho-analysis. He questions the necessity of demanding a full medical qualification from psycho-analysts, and sees no harm in the idea that cases should be referred (after diagnosis) by doctors to men "qualified in all the matters truly relevant to the application of the treatment." It seems to us, however, that these "matters" must include a thorough and examined knowledge in zoology, physiology, bio-chemistry, biology, psychology, and anthropology—practically a full medical course, and something besides. The work of a psycho-analyst cannot be placed in the same position as that of a *masseur.* By reason of his task he must be a highly intellectualised man. We are inclined to think that for the present it is the best course to leave the practice of psycho-analysis in the hands of medically-qualified specialists. The new science will automatically attract to it the more imaginative, sympathetic, and penetrating minds amongst the medical profession.

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We cannot conclude these notes without a reference to one of the greatest precursors of psycho-analysis, the Russian novelist Dostoevsky, the centenary of whose birth has recently taken place. Though oppressed by epilepsy throughout his life of sixty years, he produced a great number of first-rate novels, including such well-known classics as *The Idiot* and *Crime and Punishment.*[1] In these he plumbed the very depths of the human soul, and showed the divine fire that can smoulder to life in the most broken and dissolute characters. His works will always afford a treasure-house to the psychologist, for to his knowledge of morbid psychology he added an ability to penetrate the characters of everyday men and women.

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[1] Translations of both these novels, as well as of various other works by him, are published in the *Everyman's Library* (J. M. Dent & Sons, Ltd., 2*s.* 6*d.* each).

CONTRIBUTORS TO THIS NUMBER

"RAFEX," whose identity we are requested not to divulge, is a well-known "air" expert and an authoritative writer on aeronautics.

MR. C. S. S. HIGHAM, sometime Scholar of Trinity College, Cambridge, was awarded the Prince Consort Prize for Historical Research by Cambridge University last year. He was recently appointed Lecturer in Colonial History at Manchester University. He is the author of *The Development of the Leeward Islands under the Restoration*, 1660–1688, and *A Guide to the Colonial Records in the Public Record Office before* 1696.

The REV. WALTER WESTON wrote on *Rural Japan* in the September number of DISCOVERY. He spent many years in Japan, first as the British Chaplain at Kobe, later as the almoner of the funds of the European Community in the Far East for the relief of the great famine in Northern Japan in 1903–4, and finally as British Chaplain at Yokohama, which appointment he occupied till 1915. A taste for mountaineering took him on long expeditions into the Japanese Alps and enabled him to obtain an unrivalled knowledge, for a European, of the life of the peasants. He is a member of the Committee of the Alpine Club and of the Council of the Japan Society.

DR. E. W. SHANAHAN was brought up on a farm in New Zealand, and has a practical as well as a theoretical knowledge of agriculture. He came to England ten years ago, after graduating at the University of New Zealand, obtained his D.Sc. in Economics at London University, was recently awarded the Hutchinson Research Medal by the London School of Economics, and is the author of *The Production and Consumption of Animal Food-stuffs with a Special Reference to the British Empire.*

DR. MARIETTE SOMAN gained high distinctions in her studies of Mediæval and Modern Languages at Cambridge and the Sorbonne. During the war she worked in the Secret Intelligence Department of the Admiralty, and after the Armistice attended the Paris Peace Conference as Secretary in the Naval Section.

CORRECTION

WE regret that in the *Books Recommended* at the end of the article on "Suggestion and Autosuggestion" in our last issue, the publishers of the English translation of Baudouin's *Suggestion et Autosuggestion* were incorrectly described. The actual publishers are George Allen & Unwin, Ltd., who have now brought out a third edition at the reduced price of 10s. 6*d.*

THE RHODESIAN SKULL

THE old question of the "missing link" has been revived by the recent discovery of a human skull in a cave in Rhodesia. But as yet it is quite uncertain whether this is the oldest known human fossil extant. Thirty years ago the most ancient human remains that had been excavated were those of the Neanderthal men, found in various parts of Europe. But in 1894 the remains of a far earlier type, *Pithecanthropus erectus*, were unearthed in Java by Dr. Dubois, a Dutchman; and these were assigned to the Pliocene Age, whereas the Neanderthals probably existed in the Middle Pleistocene or last Glacial Age. Dubois' "find" was, in fact, hailed in certain quarters as the "missing link" between man and ape, but most prehistorians have since agreed that this belief is impossible. Further examinations of the Rhodesian skull have yet to be made, but it is very doubtful whether they will prove its priority in age to the Java remains of *Pithecanthropus erectus.*

The new "find," however, is almost certainly more ancient than Neanderthal man, and the interesting theory to which it gives additional proof is that the human race started its career in Africa, and migrated to Europe before the existence of the Mediterranean.

Latest Developments in Aeroplanes

By "Rafex"

Although perhaps it is not very apparent to the public, there has been a good deal of progress in aeroplane design during the latter part of the three years which have elapsed since the Armistice. It is proposed in this article to deal chiefly with the evolution of commercial machines; mainly because it is this type which is of more immediate importance, but also because the development which has taken place in military aircraft is of less universal interest and consists, generally speaking, in a change in the details of war ideas but not a great change in those ideas themselves. Commercial aircraft, on the other hand, did not exist until after the war, and therefore any types which have been since evolved are necessarily novel. It is interesting, therefore, to watch the general trend of ideas, particularly in view of the gradual departure from the overshadowing military element which predominated even in machines produced for civil use for some time after the cessation of hostilities.

Some of us, indeed, hold the view that, despite the enormous increase in aeronautical knowledge which was made possible by the War, the development of civil aeroplanes was actually to some extent retarded rather than improved by that military effort. This was for two reasons which are more or less connected. In the first place, in military parlance the word "performance" came to have a very definite meaning, implying the sum of an aeroplane's capabilities in rate of climb, "ceiling" (maximum height attainable), speed and manœuvreability—which are set down roughly in the order of their importance for fighting purposes. Now, it is not difficult to understand that the effect of their importance in war was to stamp those characteristics of an aeroplane firmly on the mentality of the designer and pilot, with the result that the earlier commercial aeroplanes showed clearly that these four points had all been treated as still of great importance. The very advertisements of these first types, as they appeared in the aeronautical Press, showed this obsession.

The second effect of the predominance of military lines of thought arises out of this craving for high "performance." To obtain these particular characteristics it was necessary to fit wings of such a shape in section that they would produce high speed and rapid rate of climb, their capacity for weight-carrying per square foot of area being of secondary importance. Above all it was necessary to have very high engine-power; and, therefore, the aeroplane in 1918 had almost become in fact what was once stated by one of our foremost pilots to be the desideratum of the fighting airman, the "largest possible engine with the smallest possible fringe of aeroplane round it."

But it has at last been recognised that the important characteristics for commercial work are not only quite other than those expressed by the word "performance" in military aeroplanes, but are even to some extent actively opposed to them, in the sense that the two sets of attributes could not be produced in the same design. Only one of the four military points is of equal importance in a commercial aeroplane, and that is speed; and even here it is generally true to say that a machine which is capable of maintaining an average speed of 100 miles an hour over the ground in all conditions of wind and weather—which implies a maximum speed of about 130 miles per hour—possesses a sufficient advantage over other methods of locomotion; particularly when the additional gain arising from the aeroplane's ability to follow a direct route regardless of the physical configurations of the ground below is taken into account. The three other military attributes mentioned above are not necessary; a very high "ceiling" is not a necessity in peace, because most touring is done at a height of 4,000 or 5,000 feet, and a maximum height of 20,000 feet is as much as can conceivably be required, while 15,000 feet is probably the greatest height to which the average commercial machine is ever likely to attain. Again, rate of climb becomes of very minor importance. For fighting work it was of course necessary for a machine to climb rapidly in order to get above an adversary—the upper berth being equivalent to the weather-gauge in a naval battle—but in the ordinary business of carrying goods or passengers from one place to another it is not of great importance whether fifteen minutes or half an hour is occupied, for instance, in climbing to a height of 10,000 feet. It is of course desirable to have a certain reserve of engine-power at starting in order that obstacles close round the aerodrome may be cleared with an ample margin of safety, but, beyond this, rapidity of climb is not vital.

Manœuvreability, again, is essentially a military qualification, for a pilot must be able to change his position rapidly to avoid enemy fire and when jockeying for position; but the peace-time carrier of merchandise has no need for these rapid changes of attitude. This attribute of manœuvreability is, in fact, directly opposed to the commercial requirement of steadiness as, generally speaking, and within limits, the greater the "liveliness" a machine possesses from the pilot's point of view, the less will be its quality of automatic stability and freedom from motion in rough weather.

It will thus be seen that, compared with the military aeroplane, the requirements for a commercial machine are moderate speed, weight-carrying capacity, automatic stability, and—most important of all—economy in operation and upkeep. This has naturally meant a considerable change in the attitude of mind of those who had during five years of war become accustomed to attack the problem of design from the point of view of fighting requirements.

For some time after civil flying became permissible in the summer of 1919, the vast majority of machines used were war-types roughly adapted for passenger-carrying, by the enlargement, for instance, of the observer's cockpit to take two passengers, with the addition of a hinged cover to provide protection from the weather. This could not last for long, as it was obviously bad economy to employ an engine of 350 h.p. or more to carry two passengers. Actually the first machine designed specially for commercial work was a biplane produced by the British Aerial Transport Company and known as the "B.A.T. F.K.26" type. It was fitted with a 375 h.p. Rolls-Royce engine and carried four passengers in a comfortable cabin immediately behind the engine, the pilot sitting in a cockpit in the upper part of the fuselage towards the tail. The advantage of this arrangement, which was followed for a time by other designers, was that it provided a comparatively easy solution of a somewhat difficult problem. It will be obvious, on a little reflection, that the fore-and-aft balance of an aeroplane may be very considerably affected by a variation in the weight carried at different points along the length. This difficulty can be overcome to some extent by altering the setting of the angle of the tail plane so as to change the attitude at which the machine will fly. At the same time it is clear that the difference between the weight of a cabin when empty and when containing a full complement of four passengers (weighing altogether about 800 lbs.) must considerably affect the pilot's power of control. This problem is solved if such passenger accommodation can be concentrated at the centre of gravity (or position of fore-and-aft balance) of the machine; and that is the reason for the placing of the cabin in the B.A.T. machine at this point, with the pilot far back to balance the weight of the engine in front. Another important feature of this machine was that the control movements of the pilot's lever were transferred to the elevators and rudder by means of rods in place of the usual cable. An interesting commentary on this innovation, which has not been followed to any great extent, occurs in the report of the Committee on Safety and Economy in Commercial Flying, appointed by the Royal Aeronautical Society last year, which called attention to the fact that the renewal of frayed control cables was found to be one of the heaviest items in the upkeep of commercial aeroplanes. The disadvantage of having the pilot so far towards the rear of the machine is that his view on coming down to land is obscured by the cabin in front of him. Accordingly this practice, which was widely adopted at one time, has gradually been abandoned, and most of the latest types have the pilot's seat as near as possible to the nose of the machine in order that he may have the best possible view in all directions. Experience and careful attention to detail design has rendered it possible for this to be done and still to retain the passenger accommodation comparatively close to the centre of gravity; although it is sometimes necessary to provide ballast where there is not a full complement of passengers. It is interesting to note, here, that many of the two-seater observation machines used during the war were almost uncontrollable if the observer's cockpit—which was situated in rear of that of the pilot—were empty, unless the place was filled by a bag of ballast. When this was not done, the machine tended to get its nose down (owing to the weight of the engine not being counteracted) into a dive from which it could not be pulled out.

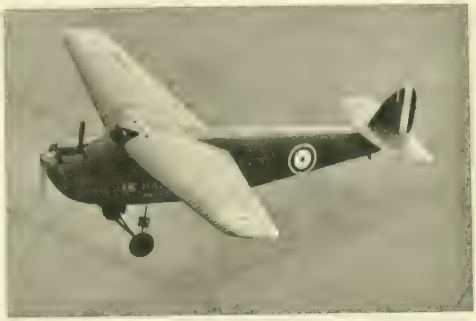


FIG. 1. DE HAVILLAND MONOPLANE.
Showing absence of bracing wires owing to cantilever construction.

The main difficulty which had to be faced by the commercial aeroplane designer was the production of a machine which would carry an economic load of passengers—which was found to be not less than six or eight—with a reasonable engine-power. At first there was nothing between the converted single-engined war-type referred to above capable of carrying a couple of passengers, and the big twin-engined ex-bombing machine, which had its fuselage made into a cabin to accommodate ten or a dozen travellers. In the one case the horse-power was usually 350–375, while in the latter it totalled 700–750. We have already seen how the B.A.T. machine doubled the earning capacity of the first type. Further progress in this direction was much assisted through the production by the Napier Motor Company of their 450 h.p. "Lion" engine, which is at the present time almost a standard fitting in British commercial machines. This made a considerable advance on any engine that had existed previously in lightness, reliability, and economy in fuel consumption—all attributes of extreme importance for civil work. The net result of the alliance of this engine with the greatly improved aeroplanes which were designed with a view to the special requirements of transport work is that the present-day single-engined 450 h.p. machine carries eight, and in some cases ten, passengers; while the twin-engined type, with 900 h.p., has seats provided for 16 to 20 passengers, which is a great improvement on the capabilities of the converted war machines just referred to. These figures, showing that the commercial load-carrying capacity of single-engined machines has been quadrupled with an increase in engine-power of only 20 per cent., demonstrate perhaps more clearly than anything else the strides that have been made in commercial aeroplane design since the Armistice.

Details of some representative types of modern British passenger and mail carrying machines may prove interesting. To take the large two-engined aeroplane first, the Handley-Page "W.8" type, which will shortly replace the converted war-bomber "O.400" type in this firm's London–Paris service, has seating accommodation for 15 passengers and is driven by two 450 h.p. Napier "Lion" engines. It has a full speed of 115 miles per hour, enabling it to maintain an average over the ground of 85 miles per hour. The saloon is a very comfortable compartment with no obstructions in the way of struts or wires, fitted with arm-chairs, beside each of which is a round glass window providing an excellent view. The two pilots sit in a small cockpit in the nose of the machine, so that they have a free outlook in every direction, and immediately behind them is a luggage compartment in which each passenger is allowed to take a certain amount of luggage free. This machine is notable for the way in which, in spite of its large size, it gets off the ground, and the steep angle at which it climbs out of the aerodrome. The same firm are making strong efforts to increase the weight-carrying capacity of all aeroplanes by introducing a patent wing which it is hoped will provide an increase of about 20 per cent. in the commercial load which can be carried with any given horse-power. This patent, which is still the subject of experiment, consists essentially in forming each main plane of the aeroplane from a number of long narrow wings with slots between instead of having one solid wing as at present. An elementary experimental application of the idea, by putting one of these narrow wings in front of an ordinary aeroplane wing, is to be seen in the illustration on this page.

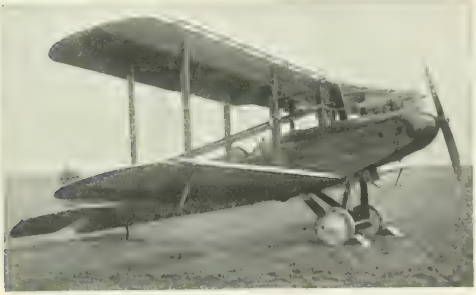


FIG. [illegible] THE HANDLEY PAGE WING.

An experimental application to show the principle.

In some ways the most interesting, as it is the latest in design, of modern British machines is the De Havilland 29 Monoplane seen in the first illustration. It is perhaps not unfair to Captain De Havilland, the designer, to say that this machine shows traces of close study of German trend in design in the sense that it is of the cantilever-type method of wing construction originally introduced in Germany. This system has the advantage of eliminating all external bracing wires for the wings, which leads to simplicity: it has a neat appearance, and probably it adds four or five miles an hour at least to the speed by reducing the resistance. The two pilots' seats are well placed on the top of the fuselage just at the leading edge of the wing, while the luggage compartment is at their feet behind the 450 h.p. Napier "Lion" engine. The passenger saloon, which, unfortunately, is hidden by the wing in the illustration, is filled with bucket-seats and has long windows along each side. A noteworthy feature is the provision of an emergency exit in the roof as well as considerable door-space in the sides, which give ample chance for escape in event of a bad landing. The tail planes as well as the main wing are entirely self-supporting without external bracing, and the control cables are led direct without passing through any fairleads or pulleys to avoid the constant renewals which the friction from such guides entails. Another interesting feature is that the engine is easily removable as a separate unit with all its accessories such as carburettors, magnetos, etc.—a most important factor from the point of view of running costs, as an engine can be changed and the machine continue in service instead of its being out of commission while engine repairs are being carried out. The under-carriage is removable, with the same object. This machine is altogether a very remarkable production, as it carries, with one 450 h.p. engine, no less than twelve persons—two pilots and ten passengers—and 500 lb. of luggage a distance of 450 miles without landing. The top speed is 130 miles an hour, and with the engine running at only a little over half-power the speed is still 100 miles an hour. Generally speaking, it may almost be said that the Safety and Economy Report of the Royal Aeronautical Society referred to above provided the "specification," because practically every recommendation contained therein has been embodied. It may be interesting to note that the cost of running the De Havilland monoplane on a single journey from London to Paris is said to be £34, while its earning capacity fully loaded is 60 guineas.

There is, unfortunately, no space in which to deal with more than one or two machines representative of modern practice, but in the same class as the De Havilland monoplane should be mentioned the Bristol Aeroplane Company's eight-passenger biplane with two pilots, commonly called the "Bristol Ten-Seater," which is, again, fitted with the Napier engine. The De Havilland 18 biplane is an intermediate type between the original B.A.T. and the later types. It was one of the first machines to be fitted with the Napier engine, and carries eight passengers; the position of the pilot in rear of the cabin, but not so far down the fuselage as in the B.A.T., is to be noticed. In his later machine, the monoplane already mentioned, Captain De Havilland has moved the pilot's cockpit to the front.

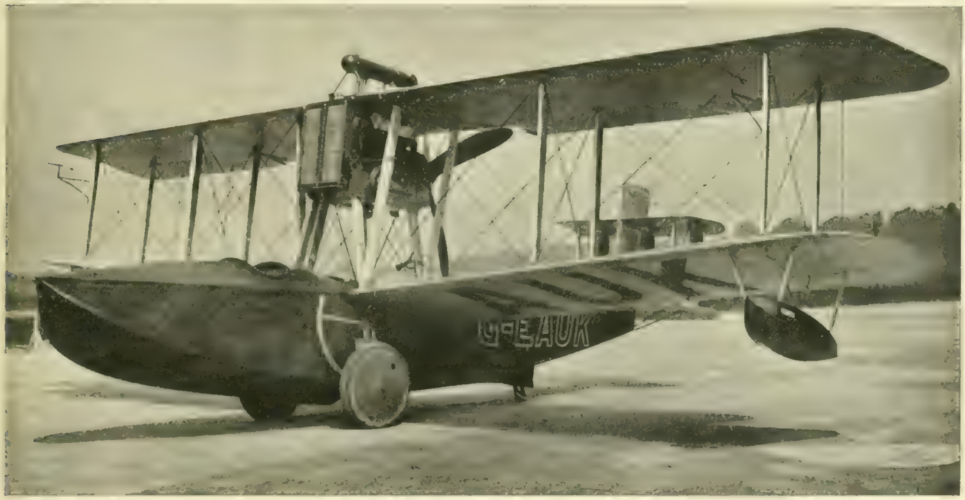


FIG. THE VICKERS "VIKING" AMPHIBIAN.
A machine for use on both land and water.

An entirely post-war product is the amphibian, capable of taking off from or alighting on either land or water. The most prominent example of this class is the Vickers "Viking" shown in Fig. 3. The machine illustrated is an early experimental model, but a commercial type capable of carrying one pilot and four passengers has now been designed. This amphibian consists of a boat hull provided with landing wheels which can be wound up out of the way by means of a ratchet gear when it is desired to use it on water. It has been exhaustively tested for both purposes, and it is a very remarkable sight to see it alight on the Thames, "taxi" to the shore, and then climb on to land under its own power on the wheels. This is unquestionably a type of great importance to an island nation such as ours, and when it has been further developed will become a serious competitor of the aeroplane. The full speed, with Napier "Lion" engine, is 119 miles per hour, and it has a range of 480 miles with the engine throttled down to 90 miles an hour. Messrs. Vickers, Ltd., also produce the familiar "Vimy" twin-engined aeroplane which made the famous trans-Atlantic, London-Australia, and South African flights. With two Rolls-Royce "Eagle" engines of 375 h.p. each, it has accommodation, in its latest form, for fifteen passengers and has a maximum speed of a little over 100 miles an hour.

It has not been possible within the confines of this article to do more than sketch briefly the progress that has been made in the short space of two years—for little more has elapsed since commercial aviation was seriously taken up—in the evolution of aeroplanes suitable for carrying passengers and goods from the engines of war upon which the industry had been previously engaged. Perhaps, however, the real development that has taken place has been sufficiently described to indicate what may be hoped for within the next five or ten years. For ideas are now becoming crystallised as a result of the experience that has been gained.

The Raid on the Bruges —Ostend Canal in 1798

By C. S. S. Higham, M.A.

Lecturer in Colonial History in the University of Manchester

THE Channel ports have long played a great part in the strategy of campaigns, and during the recent war the importance of controlling them was well illustrated; a very similar situation arose during the wars of the French Revolution, and a successful attempt was made to put the Bruges–Ostend Canal out of action. The low-lying nature of the country facilitates the making of such waterways, and the whole of Flanders is one network of canals which are of great importance for peaceful commerce, and doubly so for war. The fact is that this huge system makes the work of a blockading squadron a much more difficult task, and greatly increases the effective mouth of the Scheldt. Small craft can come by the canals from Antwerp or other ports to Bruges, and so to sea, and thus escape the seaward patrol.

When the ports were raided in 1918 there were two main points of attack. Zeebrugge was the more important, for it was connected with Bruges by a ship canal, some twenty-six feet deep, which had been completed only a few years before the war, while Ostend was joined to Bruges by an older canal, some fourteen feet deep and thirteen miles long. Thus Bruges had become a great harbour for submarines and small craft, which were built at Antwerp or other places, and sent in parts to Bruges by canal or rail; thence they were able to sally out by Ostend or Zeebrugge and take part in the intensive submarine campaign. Since the mouth of the Scheldt was closed by the neutrality of Holland, the problem was to seal the two entrances to the harbour of Bruges. In 1798 the problem was very similar: four years earlier the armies of the French Republic had succeeded in expelling the Allies from Belgium, or the Austrian Netherlands, as they then were, and had also captured Holland. Thus the Scheldt as well as Ostend, with its recently constructed canal from Bruges, were both in their hands, and news kept trickling through to us that the enemy were building vessels at Flushing and elsewhere, which were to assemble at Bruges for an invasion of England.

The plan of destroying the canal was conceived, and its details worked out by an energetic and restless sailor, Sir Home Popham, then a Captain in the Royal Navy. Popham was naturally interested in the problem, for he had served with the British troops in Flanders during the recent campaign, and had been specially recommended for promotion by the Duke of York, for his able handling of the Inland Water Transport. Previously, too, he had become well acquainted with the port of Ostend, since for several years he had traded thence to the East Indies under the flag of Austria. Here, then, was a man who appreciated the importance to the French armies of the canal system of Flanders, and who realised the threat to England contained in the new Bruges–Ostend canal.

Popham's plans were ably seconded by General Sir Charles Grey, the father of the famous statesman who passed the Reform Bill, and at that time in command of the Southern district with his headquarters near Canterbury. Grey was a keen and daring soldier who had seen service in the War of American Independence: later, in 1793, he sailed with Jervis in an expedition against the French possessions in the West Indies, and distinguished himself by the perfect co-operation he secured between army and navy when a joint attack was carried out on Martinique. He now urged Popham's plans upon Dundas, Pitt's Secretary of State, and gained his permission to prepare a secret expedition. Popham had drawn up a careful memorandum on the subject: he aimed at blowing up the canal gates at Saas, a mile above Ostend, by a combined military and naval raid. "I would have all the vessels anchor in their stations in the night," he wrote, "and disembark their Troops at high water, by which means the detachment for Saas will be there and have their Petards fixed by half ebb, which is the proper time to burst the Gates, as the water will then have an amazing fall, and will render it impossible for any boat to cross the Harbor, indeed I imagine everything there will be torn away and carried to sea by so great a body of water coming down so suddenly, a quantity of silt and mud will in course also be brought down, which may tend to stop up the Harbor, especially if a vessel was sunk there at low water." This suggestion of sinking a ship in the harbour mouth is an interesting forecast of the *Vindictive*, but it went no further at the moment. Popham also submitted a diagram to show how he proposed to employ his ships, and the covering force of troops who were to screen the demolition party.

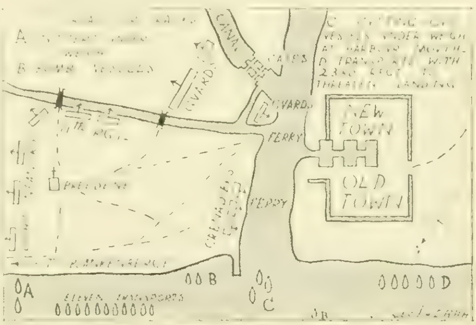
Meanwhile Grey was choosing his men and assembling them at Margate with all secrecy. "The 11th Regiment I have always meant to embark," he wrote, "they being a very good corps, and perhaps detachments from the 49th and 23rd, not wishing to embark them, but to make up the number of Troops wanted from the Flank companies; my reason for this is, the 49th are composed of raw recruits, 70 joined them on their march to Margate, and the 23rd have a great many Dutchmen in the Regt. which I do not think exactly calculated for the intended service."[1] The Admiralty, however, seems to have been dilatory, and while Grey fumed at Canterbury the plan grew, the feasibility of bombarding Flushing was discussed, while it was decided to send some of the troops, after the raid, to capture the island of Ameland and help to blockade the Texel. On May 8 the necessary secret instructions were issued to Popham, who was to command the fleet, and emphasis was laid on the fact that the main objective was the destruction of the canal gates. One sentence deserves to be noticed: "You are to endeavour to destroy by shells whatever ships or boats may be in the port [Ostend], but if there should not be any vessels which may be so destroyed, you are not to throw shells into the town, which though it might distress Individuals, would produce neither honor nor advantage to His Majesty's arms."

The troops were embarked upon the 14th, but a gale of wind forced them to anchor off the North Foreland, and Grey was left fretting ashore, writing letter after letter to town, and, when the last post was gone, even sending a dragoon thundering along the London road by night with the good news that the fleet was ready to sail. In the early dawn of the 16th the expedition got under weigh, and Grey's excitement burst forth in his letter to Huskisson, Dundas's secretary: "I beg he [Dundas] will, in the meantime and until the issue is known (which *shall be* successful) be planning in his own mind another entertainment for our neighbours, following the one, just gone forth, vigorously up, and I will answer for his making this *great* (or rather unprincipled) *nation* sick of Invasion, and cause the People to revenge themselves of the Directory, plundering Paris, in the room of England, so insolently held out to them. Mr. Dundas will have the goodness to excuse this freedom, for I must have my say."

The troops which were embarked for this expedition were made up as follows: Eight Light Infantry companies from the Guards; four from the First Guards, and two each from the Coldstreams and the Third Guards. The whole of the 11th Foot, and the Grenadier and Light Infantry companies of the 23rd and 49th regiments. There was also a detachment of some 100 men of the Royal Artillery with guns, and in addition there were ten miners chosen from Welsh militia regiments, to help with the demolition party.[2] Sir Eyre Coote, the nephew of the famous Indian General, was chosen by Grey to command, and his selection was doubtless due to his previous service with Grey in the West Indies, and to his brilliant conduct during the attack on a fort in Guadeloupe. Besides Popham's intimate knowledge of the port of Ostend and its neighbourhood, Coote had the help of two local guides, one who had been harbour master of Ostend during the British occupation, and the other a refugee.

The expedition had been timed to arrive in the early morning, and the enemy's coast was approached with great caution. By 1 a.m. on the 19th the ships were anchored, but the wind had shifted to the west and began to freshen; while Coote and Popham were discussing the postponement of the attempt, a boat from the *Vigilant* came alongside with the Ostend pilot boat, which she had just cut out from under a shore battery. The pilots, upon examination, confirmed the previous information that there were but few French troops on the coast, and Coote begged Popham "that he might be landed to accomplish his great object of destroying the canal, even if the surf should prevent his retreat being so successful as he could wish." Popham agreed, and the troops were hastily landed on the sand-dunes to the east of the harbour, without waiting for the *Minerva*, who, with the four companies of the First Guards aboard, had failed to keep touch with the convoy.

DIAGRAM OF ATTACK ON OSTEND CANAL GATES.



Adapted from the Diagram sent to Dundas by General Grey.

NOTE.—The Grenadiers and Light Infantry were the flank companies of the three foot regiments. The actual disposition of troops at the landing had to be modified, as four companies of Guards did not land.

So secretly was the landing carried out that the French were not aware of what was going on until most of the men were ashore. Then a heavy bombardment began from the forts, to which the frigates and bomb-ships replied. Coote pushed forward some Guards to seize the lock gates, which they succeeded in doing after a skirmish, and a screen of troops was thrown out to cover the working party: to the East, the village of Breedene was occupied and the Blankenberghe–Ostend road covered, while on the west detachments held the two ferries which crossed the harbour from Ostend. But the old black powder of those days was a very different thing from the high explosive of to-day, and the work of demolition a much more difficult matter: the heavy and bulky materials had to be brought ashore and then dragged across the sand-dunes for over a mile to the lock gates. While this was being done it was necessary to mislead the enemy as to the real objective of the raid, and so a detachment of troops cruised aboard some frigates to the west of the town, to make a feint of landing, while Coote and Popham, as a piece of bluff, sent a formal demand for the surrender of the town, and threatened, in case of refusal, to bombard it. To this the French commandant made the spirited reply that he would not surrender until he was buried beneath the ruins of his town; but the necessary time had been gained, and at 10.20 a.m. Popham saw the flash of the explosion, and knew that the main object of the expedition had been achieved.

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[1] The 11th Foot are now the Devons, the 23rd the Royal Welch Fusiliers, and the 49th the Royal Berkshire Regiment.

[2] The miners came from the following militia regiments: Somerset, 1; Denbigh, 2; Glamorgan, 7.

In a despatch written the same day, and headed "On a Ridge of Sand Hills, three miles to the East of Ostend," Coote announced "the compleat and brilliant success attending the expedition," but the very fact that he had time to sit and write a despatch ashore meant disaster. As the men fell back to their rendezvous for re-embarkation, with a casualty list of no more than five all told, they found that the wind had become so strong that it was quite impossible to get aboard. Two boats which were filled with men capsized immediately in the surf, and it was with difficulty that the occupants were saved from drowning. There was nothing to be done but to wait on the weather, and Coote was forced to choose the best ground he could and to dig in. About daybreak the British found themselves attacked by two columns from the front, while behind them the thunder of the surf cut off all hope of retreat; then other bodies of troops appeared on either flank, and after a desperate struggle the British left, held by the 11th Foot, was driven in, and Coote, while trying to rally them, was badly wounded. Major-General Burrard took over the command, but realised he was hopelessly outnumbered, and that both his flanks were turned, so the two generals decided to surrender at discretion, thinking it "more our duty to preserve the lives of the brave men we commanded, than to sacrifice them to what, as we conceived, was a mistaken point of Honor. Had we acted differently, it is probable, that in less time than what I mentioned, their fate would have been decided by the bayonet." Some 940 of all ranks surrendered, and there were 162 casualties: thus it came that Coote's cheery despatch of the 19th was capped next by day a letter of a very different tone from Burrard, a prisoner of war, sitting beside the bed of his wounded commander in Ostend. As for Popham, he had managed to land early in the morning only to see the troops surrounded and captured, and there was nothing for him to do but to communicate with the shore by a flag of truce, and then set sail for England.

The first news reached Grey early on the 22nd in the shape of despatches from Popham, and from the officer in command of the troops who had not been landed. Grey put the best face he could on the matter. "The elements have cruelly fought against us," he wrote; "had we but been a week earlier, when the weather was fine, all would have gone happily well, and the other objects of the expedition carried into effect. As it is, our loss is trifling compared to the importance of the object gained, and which is certainly completed in all its parts." The full details did not arrive till the middle of July, when a surgeon who had been sent to Ostend by the Commander-in-Chief, the Duke of York, brought on his return a large bundle of despatches from Coote and Burrard, and Dundas had the opportunity of reading, with a wry smile, the optimistic letter written by Coote just before the final disaster.

As to the success of the expedition, its main object had certainly been achieved, and the canal left without a drop of water at low tide; but the cost was great, for at that time England could ill afford the loss of any well-trained troops, such as the four companies of Guards. The general tendency was to magnify the success, and discount the cost; indeed, as in the St. George's Day raid of 1918, the moral effect was certainly very great. Grey himself, the very embodiment of the spirit of the offensive, summed up the matter in his energetic and sprawling hand: "There appears now a perfect lull on both sides; perhaps the old saying, after a calm comes a storm, may be verified. I hope it may on our part, for we ought never to allow the opposite coast to sleep in peace."

NOTE.—The official despatches, on which this notice is based, are preserved in the Public Record Office: W.O. 1/177. Admiralty Instructions in Ad. 2/1353. There are also several references in private correspondence, and in the newspapers of the day. See also Fortescue, *History of the British Army*, vol. iv, pt. i, pp. 587–9. For the raids of 1918 see C. S. Terry, *Ostend and Zeebrugge* (Oxford University Press, 1919).

DIRTY MONEY AND DISEASE

WRITING on this subject in the October issue of the *Scientific American Monthly*, M. Jacques Bayer states that even slightly-soiled bank-notes will, on examination, be found to harbour a "number of varieties of Saccharomycetes (including brewer's yeast and various other yeasts), great numbers of microscopic algæ and bacteria, various bacillæ, especially the *Bacterium terna*, which is the agent of putrefaction, and the *Leptothrix buccalis*, a parasite which is particularly abundant upon the tongue, in the saliva, and within the interstices of the teeth." The writer has noticed that the "differences in the bacteria found on bank-notes and on coins are not so great as might be supposed," though microbes are more disposed to the bank-note, and microscopic algæ to coinage.

The morals are obvious!

Helium

By A. S. Russell, D.Sc.

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THE gaseous element, helium, which has recently been brought into public notice by writers endeavouring to explain how the accident to the airship R38 might have been avoided, has had a curious and interesting history. Few of the elements have caused more surprises in the scientific world than this one, and none, by the mere fact of its existence, by its possession of certain properties and total lack of others, has had so important and far-reaching an effect upon present-day knowledge of the constitution of matter.

In describing this element I find it most convenient to treat it under seven headings, the subject matter of each of which is summarised below.

I. Helium was discovered in the sun, and much later on the earth.

II. The discovery of helium and argon led to the isolation of four more inert gaseous elements.

III. It has been experimentally proved that the atom of helium is "inside" the atoms of certain heavy atoms.

IV. It is probable that the atom of helium *may be* a constituent of many of the chemical elements.

V. The liquefaction and solidifying of helium have led to the coldest attained temperatures.

VI. Helium, a thing of purely scientific interest, became a necessity for balloons in war. It will become of increasingly practical importance for balloons and airships according as sources from which it may be isolated are explored.

I

Helium was first heard of in 1868, when it was discovered in the luminous atmosphere of gas which surrounds the sun. During a total eclipse this atmosphere was examined by a spectroscope and a new yellow spectrum-line, called the D_3 line, was observed. It had not been observed on the earth; nevertheless, the new spectrum-line was so characteristic as to leave no doubt that it came from a new element. For twenty-six years nothing was known about this element except its spectrum-lines and the fact that it existed in the sun and in certain stars; but towards the end of 1894 Sir William Ramsay showed conclusively that it existed in a rare mineral on the earth. This discovery was just missed five years earlier by a well-known American mineral-analyst, Prof. Hillebrand. In working up a specimen of the mineral pitch-blende (from which we get radium), Hillebrand obtained a gas which he supposed to be nitrogen, for so it appeared to be when tested by the ordinary methods; but one or two curious happenings that occurred during his experiments led him to suggest to his assistant jocularly that possibly they might be also dealing with a new element. The matter, however, was not pursued farther.

In 1894 the gaseous element argon had been discovered in the atmosphere by Lord Rayleigh and Sir William Ramsay, and the latter in searching for new sources of this gas had his attention called to the "nitrogen" which Hillebrand had prepared from pitchblende. It was suggested that this might contain argon. Ramsay repeated Hillebrand's work, proved as Hillebrand had done that it contained some nitrogen, but found by the spectroscope that most of the gas was not nitrogen, and not argon, but the long-awaited helium.

It is a curious thing that often when an element has been discovered, no matter how difficult it had been to detect in the first instance, it is immediately found nearly everywhere without much difficulty. The explanation is simply that when keen and active minds have been told to look for something new, and given the necessary information to recognise it, it is largely a matter of their looking hard enough to find it.

Helium was soon found to be a constituent, but always in small quantity, of the atmosphere, of a certain class of rocks, of many mineral springs, of the sea, and of the natural gas that comes out of the ground chiefly in America. It is also found in the hotter stars and in meteorites; so that it is widely distributed.

II

A development of great theoretical interest in chemistry arose from the discovery of these two gases, argon and helium. These gases were found to possess no chemical properties, i.e. they refused to combine even under most favourable conditions with other elements. This was strange and novel behaviour, and it set many minds thinking. Now this refusal might arise for one of two reasons: (1) because these elements were completely inert and lacked the power of uniting with other elements; or (2) because they were so very active that each gas was wholly occupied in combining among itself, and so had neither opportunity nor "desire" to combine with other elements. The first of these views was adopted, and it is important because it had an interesting consequence. For if argon and helium are inert elements they are unique, i.e. they form a group by themselves. But in the Periodic System of classification such a group, if like other groups, has six members. It followed therefore that, if a new group of elements existed, and if two of them had already been isolated, four remained to be found. The truth of this view was borne out by experimental work. Three of the four—neon, krypton, and xenon—were isolated from the atmosphere by Ramsay and his co-workers in the 'nineties, and the fourth, radium emanation (or niton), was discovered emanating from preparations of radium.

III

An element isolated for the first time on the earth in 1894, and which had led directly to the discovery of four more elements in the years immediately following, had certainly made its début, as they say, with a certain degree of éclat. But even Ramsay, who was surprised at his own discovery in 1894, was still more surprised in 1903 when Soddy, in conjunction with him, proved definitely what Rutherford had suspected, that helium was produced continually by the element radium. The work of Ramsay and Soddy proved that the radio-active element radium on disintegration broke up cleanly into two elements, the emanation and helium.

	Radium	→	Emanation	+	Helium
	solid		gas		gas
Atomic weight	226		At. wt. 222		At. wt. 4

This was shown by freeing a preparation of radium completely, both from the emanation and from helium, and proving by the spectroscope that the latter accumulated in the preparation with time. This work caused a mild sensation among scientific workers of the period, because it proved definitely, what workers in radio-activity had tentatively begun to assert, that one *element* may decompose into two elements. The suggested explanation of these facts is as follows:

The atom of helium must be originally inside the atom of radium, and for some reason it is shot out with great velocity. All the expelled atoms of helium form helium gas; all the shattered atoms from which the helium atoms have been shot out form radium emanation gas. The atomic weights of radium, of the emanation, and of helium are known by *independent* experiments to be 226, 222 and 4 respectively, so that the breaking-up of radium is numerically right, since $226 = 222 + 4$.

Further study of radio-activity showed that the expulsion of helium by radium was not an isolated phenomenon. Several other elements expelled the atoms of this gas. We now know that the element uranium (which is used commercially for making pigments) has at least eight of these helium atoms in the inside of its own atom, while the element thorium (compounds of which are used for making incandescent gas mantles) has at least six, and the element radium five. These are experimental facts about which physicists have no doubt. Helium, then, appears to be a constituent of the very heaviest elements. It is not joined to them in the loose way that atoms forming chemical compounds are, but in a more fundamental way that is quite unlike any combination in chemistry.

If helium can be proved in the laboratory to be produced by the breaking up of heavy atoms, then clearly there should be relatively large quantities of the gas in rocks containing these heavy bodies—untouched for thousands and thousands of years. Experiments have proved this to be true, and indeed one method (though not a good one) of estimating the age of these rocks is to measure accurately the quantity of helium which a known mass of these heavy elements has produced. It is believed that the quantities of helium found in the atmosphere, in mineral springs, etc., have come from the decomposition of rocks containing the heaviest elements. These indeed, like the helium they produce, are very sparsely distributed on the surface of the earth, as the unfamiliarity of their names, uranium, protactinium, thorium, ionium, etc., to all but specialists bears witness.

IV

Two important speculative ideas have been suggested by the experimental fact that helium is a constituent of the heaviest elements, namely:

(1) That helium is a constituent of all elements, or at least of many elements besides the heaviest.

(2) That hydrogen, which is the only known element lighter than helium, may also be a constituent of many elements.

The first of these alone is germane to my subject, and will be considered now. Helium is inside some heavy elements; it is natural to infer the possibility that helium is a constituent of most elements. This speculation appears to work excellently on a sheet of paper. A number of elements have atomic weights which are nearly exactly whole numbers that are divisible by 4, the atomic weight of helium. For example, carbon (12), oxygen (16), neon (20), sulphur (32), titanium (48), chromium (52), iron (56), tungsten (184), thallium (204), thorium (232). What is easier, when one is speculating, than to assume that these elements are built up exclusively of helium, i.e. that carbon is three helium atoms bound in a very fundamental way, oxygen four, iron fourteen, and thorium fifty-eight?

A simple speculation of this kind includes only those elements which have whole numbers divisible by four for their atomic weights, but if we consider a few proven experimental facts we can extend it to a great many more elements. These facts are:

(1) That all atomic weights are probably whole numbers.

(2) That an atom of hydrogen, weighing 1, exists in certain atoms (boron, nitrogen, fluorine, sodium, phosphorus, etc.).

Now every integer when divided by four gives a remainder of 0, 1, 2, or 3. In the first case speculation says the body is composed entirely of helium, in the second of helium and an atom of hydrogen, in the third of helium and two atoms of hydrogen, and in the last of helium and either three atoms of hydrogen or something else. But, of course, suggestive as these speculations are, experiment and that alone can say what the constitutions of the different elements really are. Already in one or two instances, where speculation seems clearly right, experiment has shown it is not right. Literary critics of undoubted learning and insight sometimes ascribe the authorship of an anonymous work, on internal evidence, to a certain man, and find later when the name of the real author comes out that their theory of the authorship, though clever, was quite wrong. This is an analogy from the world of letters.

But although details are at present meagre, the general idea that helium is a constituent of most of the chemical elements is considered to be broadly correct. This view receives encouragement from the astronomical facts that the hottest stars contain the light elements, hydrogen and helium, and, as the star cools, elements of greater atomic weight gradually make their appearance until, in a cold planet like our own, they exist in great variety. This suggests the formation of the heavy and complex elements out of the light and simple ones, of which the chief is helium.

V

The liquefaction and solidifying of helium have led to colder temperatures than have ever before been attained. The element does not become liquid until 4½°, or solid until 2½°, above the absolute zero of temperature. Before 1908 helium was the only gas that had resisted liquefaction. The main difficulty was to get the gas down to a temperature low enough for the ordinary process of compression and expansion, by which a gas is progressively cooled to its liquefaction point, successfully to begin. After several workers had given the problem up a Dutch experimenter, Kammerlingh Onnes, succeeded. Helium was found to boil at less than 4½° Centigrade above the absolute zero of temperature. The same worker, by allowing the liquid to evaporate quickly, succeeded in obtaining the substance solid—a marvellous achievement. It is wonderful to think that man has approached within about two degrees of the very coldest temperature that can exist anywhere in the universe!

VI

It was the war that gave a practical use to helium. It is, on the whole, the best gas for filling balloons and airships. In two respects hydrogen, which has hitherto been used for this purpose, has decided advantages: it is the lightest gas that is known and therefore the most buoyant, and it is very cheap and easily prepared in quantity; but, if safety be considered, it cannot be compared for a moment with helium. Many serious accidents happen to balloons and airships: bullets in war time and accidental fires in peace which set the hydrogen on fire. Helium, when it is pure, is perfectly safe in this respect. It will neither catch fire nor explode. The engines of the airship, indeed, may be placed inside the envelope containing the helium. Nor is the greater density of helium the serious factor which at first it may appear to be. Helium is the second lightest known gas, and its density is nearly twice that of hydrogen. Now the lifting power of a balloon or of an airship is proportional to the difference between the densities of the gas in the envelope, and of the air displaced by it. For an approximate calculation the densities of air, helium, and hydrogen may be taken as 14, 2, and 1 respectively. Thus the lifting power of helium is proportional to $14 - 2$, i.e. 12, and that of hydrogen to $14 - 1$, i.e. 13. Their lifting powers are therefore as 12 to 13, or, expressed otherwise, that of helium is 92 per cent. of that of hydrogen. This, of course, is not a serious difference, and may be somewhat reduced by heating the helium electrically, thereby decreasing its density and so increasing its buoyancy.

The grave difficulty in substituting helium for hydrogen lies in the trouble and expense of getting an adequate supply of the former. The airship R38 had gas-bags which held about 2,750,000 cubic feet, while helium is apparently a rare element, widely distributed perhaps, but always in small quantities. In the atmosphere near the earth only there is, for example, 1 part by volume of it in 185,000 parts of air. (Higher up, however, it has been calculated, the amount is greater, and sixty miles up it is said to be nearly 1 part in 200. Other theorisers claim that the atmosphere at this height consists almost entirely of helium. But how are you going to bring it to earth?) Again, in the gases from mineral waters the amount of helium is rarely as high as 1 per cent., though one spring in France contains more than 5 per cent. About 1½ is the highest percentage that has been found in natural gas.

These results show that, unless the sources are very abundant, and the methods of separation cheap, helium must be a costly substance. An investigation of the helium sources throughout the Empire, and the best methods of separating it, was begun in 1915. The natural gas of Canada (and later of U.S.A.) was found to be the best source; the best method of separation to be fractional distillation. Plants were erected which produced 50,000 cubic feet per day at a cost of about

£20 per thousand cubic feet. Now the envelope of a kite balloon has a capacity of about 25,000 cubic feet. A [illegible] plant could thus fill two of them a day at a cost of £500 each. An airship like the R38, with a capacity of 2,750,000 cubic feet, would need 55 days' output, and the cost of the gas would be about £55,000 ! These figures seem very pessimistic, yet really they indicate a great advance. Until the war helium was regarded as being of scientific interest only, and the idea of filling a balloon with it would have been regarded as being as fantastic, it has been said, as paving the Strand with diamonds.

The practical man knows that much has to be done before helium will be cheap, but we may safely trust the men whose enterprise is directed at effecting this in the future. Needs must. . . . Helium is scientifically the safest gas for balloons and airships ; man must therefore have it.

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Some Social Survivals of Rural Japan

By the Rev. Walter Weston, M.A., F.R.G.S.

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A STRIKING feature of the activities of agricultural Japan is the part played in them by women. In the planting, transplanting, and harvesting of the rice, they are always to the fore, and they tend the silkworm and conduct nearly all the operations connected with it ; they pick and later on fire the tea. In fact, no labour comes amiss to them. So it is not surprising to find that, in a country notorious above all others for its large percentage of divorces, the proportion of these is lowest among the rural population. It is also not surprising that these useful and inexpensive helpers have relatively more liberty and a higher position than the wives of the "upper" classes. The wife of the peasant shares not only her husband's labours but also his counsels, and it is often she who keeps the purse and really governs the family. At one hamlet in the Southern Japanese Alps, I found the heads of households were all women, and was informed that for any male outsider, rash enough to intermarry there, life was apt to be both bitter and brief. The place was known as *Onna-taka*—"Woman's Hill"—and, thanks to the rule of a bitter tongue and a heavy hand, that fact was not suffered to be overlooked. Sometimes one was told of a village that it was notorious as *kaka-denka*—"woman's throne"—which, too, denoted a similar relation of the sexes.

In the secluded hamlet of Narada, in the Southern Alps, all the inhabitants bear the same name, Fukazawa, and it is perhaps due to the traditional pre-eminence of women in bygone days that the "Seven Wonders of Narada" are proudly pointed out to the traveller as the gifts of a beautiful and gracious lady, who once visited the valley and endowed it with these treasures. The chief of them have a specially domestic value ; there is the pool whose waters, used for laundry purposes, have magical properties ; there is the "Betel-nut Pond," in which articles of clothing embedded in the bottommost mud assume the deep purple-black hue which is highly prized ; and there is the "Salt Pool"—until the visit of the Fairy Godmother of Narada, salt was unknown to the Fukazawa families, but the waters of this pool, saline and exceedingly hot, made it possible for them both to season and cook their vegetables in a single process.

Domestic institutions of an extraordinarily primitive character exist in some of the remoter valleys, as, for instance, in that of the River Shirakawa. This lies in the province of Hida, in the centre of the main island, popularly called the "Island Province" on account of its isolated and inaccessible character, for it is cut off from the rest of the island by a cordon of lofty mountain ranges. It is also singular as the one province which, in feudal times, knew no *samurai*[1] and acknowledged the rule of no *Daimyo* (feudal lord). In this valley one finds whole families dwelling under one roof of gigantic size, for the family includes not merely parents and children, but also uncles, aunts, nephews, nieces, grandchildren, and other relations to the number of fifty or more. The heads of such families have almost despotic authority, and only the heir, who is usually, though not invariably, the eldest son, is allowed to marry. The other sons make irregular unions, the children of which are adopted into the family of the mother. Some of the " villages " number only two or three houses, while in one case there is but a single house and to that is allotted a post-office of its own! In some of the side valleys leading off the main one a distinct type of physiognomy has been observed. While the girls are noted for their good looks, both they and the men generally possess oval faces, a white complexion and regular features. My friend, Mr. Oswald White, the British Consul at Nagasaki, one of the few European travellers who have visited the valley, tells me that these types appear to be possibly of Korean origin, a conjecture which has additional support from the fact that the northern borders of the province in which they are found are within a few miles of the sea, across which Korea is easily accessible.

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[1] *Samurai*, from *samurau*—"to guard," or "be in attendance on"—was originally used of the soldiers stationed at the palaces of the Mikado (="Sublime Porte"), but later on was also applied to the retainers of the Daimyo of the feudal ages. Its equivalent in English connotes the "warriors," "Military class," or "gentry." Feudal Japan expected all gentlemen to be soldiers, and all soldiers to be gentlemen. The mental outlook of the *samurai* greatly resembled that of the nobility and gentry of our own Middle Ages. Birth and breeding alone counted, and not money, while unquestioning obedience was expected and cheerfully rendered.

A tragic light was thrown on some of the strange social survivals that are occasionally encountered in secluded communities far removed from the sphere of law and order administered by their official representatives, through the discovery, by my hunters and myself, of the remains of some unfortunate man who had met the fate most repellent to a Japanese—a violent death followed by no burial rites. Near the foot of a peak in the heart of the Northern Japanese Alps we found the bones of an outlaw whose fellow-villagers had expelled him from their midst many years before on account of his quarrelsome disposition and unruly deeds. Some sort of mutual discipline was an absolute necessity in lonely spots where no guardians of the peace were at hand to help. For the common good it was usual, in the case of such a persistent and intractable reprobate, to erase his name for ever from the village register, to present him with his birth certificate, and then drive him forth never to return. He then became a *hi-nin-a* (" no man "), a human being who no longer possessed the rights or privileges of manhood or of citizenship, for henceforth he belonged to neither State, village, nor family. He was not only without a home, but almost without a hope in the world, for it was practically impossible for him to obtain employment or assistance of any kind, however sore his need.

The hideousness of such a prospect can be fully understood only by those who are familiar with the exceedingly sociable character of the dwellers in rural Japan and the communistic nature of their daily life and toil. There is, perhaps, no more interesting or entertaining illustration of this engaging feature of peasant life than is to be seen in the habits and customs connected with the use of the " honourable hot water," whether in the semi-private bath of the country inn, or in that public and popular institution, the mountain mineral spring. Each of these is characteristically Japanese.

The European traveller on the unfrequented ways, if he asks for the bathroom, will be conducted to the corner of the front verandah of the house and invited to step into the large oval tub that serves for bath, and there submit to that process of prolonged soaking which constitutes the Japanese idea of a hot bath. He will be expected to do this in full view of the friendly passers by, with whom he can the more pleasantly pass the time in conversation. There is, however, usually some competition for the privilege of the first dip, if such a term is sufficiently descriptive of an operation which involves a half-hour of parboiling at a temperature of 110–115° F., succeeded by the actual washing done *outside* the bath. Next follow, after his exit, the other guests in order of arrival or of dignity, as the case may be—men *always* first, then the landlord, succeeded by the remaining males of the family. Finally, after the landlady and the other female relatives have finished, come the domestics, irrespective of sex, according to the size of the tub and to the number desirous of getting in at the same time. Thus the splashing and chattering go on without ceasing for five or six hours at a stretch.

WOMAN CUTTING RICE STRAW

But it is the mountain mineral spring—the *onsen*—that furnishes us with the most striking and characteristic popular institution of rural Japan, giving, as it does, full scope to the sociability of its inhabitants; there is nothing quite like it in any other land. It is a natural outcome of the highly volcanic mountain ranges in which the country abounds and it is highly prized by the peasantry and by the many outside visitors attracted to the healing waters, either for the sake of health or in order to kill time pleasantly in the company of their friends. Although in some cases one now finds separate compartments reserved for those who prefer to bathe privately, it is much more usual for a number of persons to bathe together without distinction of age, sex, or class. At one time in some of the towns, out of deference to European ideas of privacy, a cord was stretched across the big wooden tanks with the notice, "This side for ladies: that for gentlemen." But in the country-side such refinement is rarely observed, yet everything is conducted with the utmost propriety and decorum.

A SECLUDED VALLEY ON THE WESTERN OUTSKIRTS OF THE MAIN RANGE OF THE NORTHERN JAPANESE ALPS.

Among the more educated habitués of the *onsen* are found young men of the student class, holiday-making in the hills whose favourite pastime is to beguile the hours spent in the bath with the recital, in the loud falsetto affected by the Japanese drama, of portions of popular plays, to which the damp air and confined space are held to lend enhanced effect. In this respect they differ seriously from the ancient Greeks, whom in so many other ways they resemble, for the Athenians considered noisy singing in the public baths a particular sign of boorish behaviour. One of the *onsen* in the Northern Japanese Alps, Shirahone in Shinshu, has been in the possession of the family of its present owners for three hundred years. When my wife and I visited it in 1914, we noticed the edge of the main public tank was lined with a number of large water-worn boulders from the bed of the neighbouring mountain torrent. These, we were informed, were for the use of the bathers, who lay them in their laps at night when going to " bed " to prevent them from " turning turtle" and drowning in their sleep! Such hardened habitués will spend three or four weeks at a stretch, practically with no break, in the water, and a case was mentioned to me by a friend, Professor Chamberlain, of the old caretaker of an inland spa who used to pass the whole winter in the soothing waters of his own particular spring. When my friend visited another spring in the summer the inhabitants apologised for their dirty condition; "for," said they, "we are now so busy that we are only able to get two baths a day."

"How often, then, do you manage to bathe in winter?" he asked.

"Oh, then we are not so busy and can have four or five baths a day, and the children get into the hot water whenever they feel cold."

One spa I visited had a list of twenty-eight specific diseases it could cure, beginning with brain disease and ending with paralysis. The only complaint stated to be incurable was the disease of love!

The obstacles in the way of inland transport in Japan are indeed formidable, since three-quarters of the country's area is mountain land. There is this year being celebrated the jubilee of the completion of the first railway, the stretch of eighteen miles between Tokyo and Yokohama, opened in 1871, but during the intervening years no less than six thousand miles have been added, and only those who are familiar with the immense and varied natural difficulties met with can adequately appreciate the greatness of this achievement. In the Nakasendo portion of the Central Railway—between Kyoto and Tokyo, one of the most mountainous regions in the main island—95 tunnels and 350 bridges had to be constructed. And yet, in spite of the immense progress thus accomplished, there lie thousands of square miles of mountain-land and forest sparsely populated or inhabited only by a few charcoal-burners, fishermen, and wood-cutters, whose means of transport and of intercommunication are of the simplest and often of the roughest nature. Leaving behind the region of the rail and the motor-car, we find ourselves committed to the untender mercies of the native carriage known as the *basha*, whose appearance is a cross between a hearse and an ambulance wagon, while its behaviour on the average country road, boulder-strewn and rutty, deep in mud or dust, frequently suggests the prospect of its employment in the capacity of one or other of those conveyances. Under favourable conditions it can cover four to five miles an hour. On mountain paths inaccessible to the *basha*, baggage is transferred to the back of the weedy and infrequent horse or to that of the more sturdy ox, or, when neither of these is obtainable, to the shoulders of the peasant coolie whose simple good-humour and friendly companionship is a very attractive feature of one's wanderings away from the beaten tracks of modern Japan. The carrying capacity of some of these is considerable, in spite of their smallness of stature and often slightness of build, although it is often the young peasant girls whose feats of porterage are most remarkable. I have met maidens of fifteen or sixteen toiling up a steep mountain pass under a load of logs over 100 lb. in weight.

Another entertaining, and at times exciting, method of transport, linking up the Tokaido Railway with the pilgrim-routes further in the interior, is occasionally encountered in the foot-hills near the broad-spread base of Fuji-san. This is provided by the quaint one-horse tramcar. The downward car always has the right of way, a privilege its conductor exercises to the full. Sometimes the ascending rival is hoisted bodily off the rails, or the occupants of both change places. On one occasion a freight car, laden with luggage, was taken in charge by the conductor of that in which I was travelling, whereupon he unyoked its labouring horse, mounted the roof, and thus rode down in triumph to the next siding, where he shunted it to await a suitable opportunity for removal, and then resumed his own proper command. Some years ago, for the benefit of any possible European travellers, the follow-

'YUBA' BATH HOUSE OF SHIRAHONE ONSEN IN THE NORTHERN JAPANESE ALPS

This *onsen* has been in the possession of the family which still owns it for over 300 years.

[illegible] was posted in one of these vehicles, though it is only fair to explain that the apparent discrimination was by no means intentionally offensive :—

All parsons who are intoxicated, lunatics, or infected are not allowed in here!

The rural Japanese always show courtesy and kindness to strangers, a fact which I emphasised in an earlier article in DISCOVERY,[1] but I cannot refrain from giving some further illustrations of these characteristics here. Years ago, in the course of the exploration of the fine but unfamiliar peak of Akaishi-san, in the central mass of the Southern Japanese Alps, I was conducted, through the kind offices of the local policeman, whose remote and lonely beat took him nearest to the foot of my peak, to the shelter of the *onsen* of Koshibu, the most secluded I had ever yet seen, and hitherto unvisited by any European traveller. Its guardian was a venerable old man of seventy-three, with patriarchal air and prince-like manners. The large bath tank, some twelve feet square, with its water heated to about 120° F., stood before the entrance of the rough *chalet* which did duty for an inn, and was occupied, on my arrival, by a dozen bathers of both sexes. My request for accommodation was received with many signs of embarrassment and with apologies for the deficiencies of his house; "for you see, sir," said he, "you are the first foreign gentleman I have ever seen and my accommodation is so disgustingly filthy that it is abominably rude of me to offer it to you." He subsequently, unknown to me, turned out the family party occupying the best room, such as it was, and offered to eject the bathers from the bath, in order that I might enjoy them both in privacy. He only begged one favour in return, which was that when the time for my evening meal arrived he might be allowed to sit on the doorstep of my chamber and watch me eat in "foreign style with foreign food." During the days of my sojourn under his primitive but most hospitable roof his sole prepossession was to minister to my comfort and, indeed, to anticipate my every wish, slender and simple though his resources were. When at length I was about to take my leave and no bill was forthcoming, I begged to know the amount of my indebtedness. At first he refused payment, but at length, after much persuasion, he succeeded in stammering out:

TWO HUNTERS IN THE NORTHERN JAPANESE ALPS.

Note the two distinct types: on the left the pudding faced Japanese peasant, and on the right the Korean.

"Do you think that 5 *sen* (a penny farthing) would be too much?"

On my way back down the valley I paid a second visit to a little inn whose landlord had already received me with much hospitable attention. No sooner had I arrived than he at once dispatched, unasked, a messenger to a village in a neighbouring valley to bring back for my inspection a wonderful stone which he was told had been discovered in the stomach of an *iwashika* (mountain antelope), the chamois of the Japanese Alps. It proved to be about the size and shape of a turkey's egg, of a buff colour and quite smooth, except on one side where a piece had been chipped off. Subsequent investigation revealed it to be a *bezoar* stone such as is described by Dr. Bonney in his *Alpine Regions*,[2] p. 180, when speaking of the chamois of Switzerland: "Owing probably to the resin contained in so much of their food and its fibrous character, a hard, dark-coloured ball, from the size of a walnut to that of an egg, of a bitter taste but of a pleasant odour, is often found in their stomachs. This is called 'Bezoar,' and it was anciently supposed to cure all evils and to be a protection even against musket shots."

Later on I found myself once more beyond the region of hotels or inns, bound for the ascent of Jonendake, another fine peak hitherto unascended by foreign travellers, and was constrained to throw myself on the hospitality of a complete stranger, the patriarchal head man of a small scattered hamlet in the foot-hills west of the Matsumoto plain amid the Northern Alps of Japan. On making known my object, I was received with the politest of greetings, first from the good *soncho* and then from his eldest son, and after tea and cakes had been produced on the verandah we moved into a beautiful guest-room, which, with humble apologies for its "disgustingly filthy accommodation," was placed at my disposal. Nothing could have been more delightful than the attentive interest with which my plans were listened to, though the idea of a stranger coming so far and taking so much trouble to climb unknown mountains for pleasure was wholly unintelligible to these old-world dwellers in the fields. The most experienced hunters of the little hamlet were summoned to act as my guides, and when I fared forth at dawn on the morrow I found that, to do me special honour, the son of the house himself was there to bear me company. On the evening of the following day, after a delightful and successful expedition, we approached the parental roof once more, when, to my surprise, my companion abruptly left me without a word and disappeared within the family apartments. For the moment I felt considerable embarrassment at the possibility of some unwitting offence on my part; but when presently a little maid appeared and, bowing her head to the matted floor, humbly begged me to "augustly condescend to enter the honourable hot bath," I saw my young friend's haste had been simply due to his hospitable desire to have my bath ready on my arrival. To this day, over the intervening years, I can still gratefully hear the farewell greeting with which the next morning I was sped on my way: "Please honourably deign to come back to us again." I felt anew that the ancient title of his land, *Kunshi no Koku* ("the Country of Gentlemen"), was still justified in such men as the Yamaguchi *soncho* of Iwahara.

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[1] Vol. ii, No. 21.

[2] Published by Deighton, Bell & Co., Cambridge 1868.

British Agriculture and the Food Supply

By E. W. Shanahan, M.A., D.Sc.

THE Government has decided to decontrol agriculture, but, even if this decision had not been taken, it is fairly clear that, so long as Great Britain retains its industrial prosperity, it cannot hope to obtain much more than one-half of its total food consumption from within the British Isles. For over a century past the latter have been a deficiency area in respect of food-stuffs.

Time and again in the past, but especially during the war period, it has been maintained that this country could easily become much more self-supporting in the matter of food supplies of non-tropical origin. Nevertheless, during the last fifty years, except for a brief period between 1915 and 1919, there has been a gradual but continuous decline in the proportion of the total food consumed in the United Kingdom that was actually produced there. These islands are not adapted to cereal cultivation on a large scale; good wheat land is limited, the climate is uncertain, and the profits to be derived from this branch of agriculture relatively small. Except in favoured parts, therefore, wheat crops tend to be grown as little more than a sideline in the general scheme of rotation-farming. An extension of the wheat-area at the present time could be obtained only at increased prices for all wheat raised here, and the increase would necessarily fall directly or indirectly upon the nation as consumers and render it that much poorer. Some money might be saved from "going out of the country," but it would be dear money.

The present standing of British agriculture is due to a balance of remunerativeness between that industry on the one hand and manufactures and commerce on the other. Great Britain has hitherto been a relatively rich country just because a number of its citizens were engaged in business more remunerative than agriculture; they received on the average a greater return for, say, each hour's work than did the people of most other countries. If manufactures, mining, and commerce had not been so profitable, it is almost certain that a greater proportion of the population would have been engaged in producing food and that the country would have been more self-supporting in respect of such necessities. We cannot have it both ways. To wish now for a greater proportion of home-grown food in our dietary is to wish that we should all be poorer, either through having to work harder for what we get, as some of our neighbours do, or by getting less for the same work; unless farmers as a body become very intelligent and enterprising and the internal system of marketing farm-produce much more economical; or unless, forsooth, we can persuade those engaged in agriculture to work harder than the rest of the population without extra remuneration. We could, of course, contrive to levy a tax on all non-agricultural industries, and assist agriculture with the proceeds, and thus probably succeed in diverting some attention from the former to the latter, from the more profitable to the less profitable industry.

It would indeed be remarkable if the people of the British Isles were now producing anything approaching the whole of their food requirements. Owing to their wealth they have learned to expect a high standard of diet, one in which foods such as meat, that require for their production a comparatively large area of land per unit of nourishment, occupy an important place; so that the agricultural resources demanded by each inhabitant in Great Britain are greater than for any other country in Europe. Not only do the British Isles carry a denser population than almost any other European country, but they contain extensive areas of unproductive land in Scotland, Ireland, Wales, and even in England, so that their density of population per square mile of productive area is nearly as great as that in any region populated by white races, and is much greater than in most such. Nor do they contain extensive areas of rich alluvial soils or loam-covered lands such as are found in a number of other densely peopled regions. Finally, in no other country in the world is such a large proportion of the population engaged in non-agricultural pursuits. In pre-war years Great Britain was easily the first manufacturing and commercial country in the world. Had it also been able to supply locally most of its food, its people would certainly have been by far the most energetic of races, and their wealth would have been great enough to hold the rest of mankind in tribute.

Those who urge a great extension of agricultural productiveness in the British Isles are apt to refer us to some of our neighbours as examples of what can be done, in particular to Denmark and Holland. Now, undoubtedly, the people of these countries make better use of their soil resources than we do. In the first place, however, they probably work harder than English people, and give more attention to detail, either by necessity, by nature, or through choice. Moreover, with the exception of commerce in Holland, there are no great competing industries in either country, so that the best brains turn largely to agriculture. This leads to a homogeneity of interests among the people, and the policy of the governments tends to favour that industry in which most of its citizens are grouped. Apart from all this, the agricultural surplus of these countries as usually given in the form of gross exports is deceptive. It is the net surplus that matters; now Holland imports a much greater value of food materials than it exports, and from the value of Danish exports of animal produce nearly one-half has to be deducted for imports of cereals, food-stuffs, and fertilisers; both countries, like Great Britain, depend largely upon external sources for their supplies of bread-stuffs.

In almost all the countries of North-Western Europe the normal imports of feed-stuffs are partly disguised in the form of enormous consignments of food materials for animals. In point of fact, Denmark and Holland have largely transformed their animal industries into a species of manufacture; they convert the imported maize, oil-cakes, etc., supplemented with home-grown fodders, into high-class goods, such as butter, bacon and eggs, for the export trade. There are similar extensive imports of feeding-stuffs into Great Britain and Ireland, which might conceivably have been lessened by an increased production of home-grown fodders. Failing such increase in the future, there would, in order to produce more of our meat and dairy produce at home, be a greater, rather than a smaller, dependence upon shipping to carry food materials directly or indirectly to our shores, since it takes not less than 10 lbs. of grain to produce 1 lb. of meat. The trouble would not end there, because, owing to the normal excess of inward over outward cargoes, it follows that all inward freights would tend to rise.[1] If by any chance the people of the British Isles decided to import sufficient quantities of feeding-stuffs to produce all their requirements in animal foods even with the maximum of farm-grown fodders, they would soon be up against an economic *impasse* on putting the plan into practice; the rise in the prices of imported fodders, together with the simultaneous fall in the world prices of meat and butter, following upon the restriction of the chief market for the latter, would turn any possible profit into a loss, unless the whole change were made very slowly; even then a point would probably arise some time before the transformation was complete, when home conversion of feeding-stuffs would be unprofitable; for the heavier freights would be a standing obstacle, and there are, moreover, many overseas areas that, owing to scarcity of labour, to climate, and to abundance of grasslands must be pastoral rather than agricultural, whatever were the relative prices of pasture-produced meat and butter on the one hand, and grain and seed fodders on the other.

Agriculture in the older-settled regions has to face fierce competition from the newer. This holds in North America as well as in Europe. Thus, American statistics inform us that the States of New York, New Jersey, Massachusetts and Pennsylvania, formerly in the main agricultural States, now annually consume together 105,000,000 more bushels than they produce. A predominantly manufacturing area such as North-Eastern America or Great Britain can scarcely afford to raise its food prices above the world level in order to protect its farmers. That would involve its industries in the payment of wages containing an excess element in the form of the difference between its food prices and those of the areas in or with which its products would have to compete. The British farmer is in the unfortunate position of being compelled to see the interests of his business take a second place; he must subserve the life-forces of the nation.

Assuming that means could be devised to render the British Isles largely independent of external non-tropical food supplies, there would be disadvantages, perhaps even dangers, to be reckoned with from the Imperial point of view. The four leading self-governing Dominions look to Great Britain as the chief, and almost the only, market for their principal exports, namely agricultural products.

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[1] Since some ships already have to leave British ports partly or entirely in ballast, any change such as that suggested, involving an increase in the tonnage of goods imported, would mean still more unprofitable space on outward voyages, the cost of which would be added to inward freights.

The complex economic tie is the chief bond that unites these new British lands with the old one. More than that, it gives British manufacturers seeking markets in these countries a pull over competitors, because the Dominions prefer to buy from their chief customer, even if prices are somewhat higher, and because the large streams of shipping employed in carrying agricultural produce home to Britain, provide space and more reasonable freights for British manufactures outwards. If the British market for agricultural products were largely lost, an unfavourable readjustment might follow in the trade in her manufactures.

May it not be urged, however that British farming has advantages of a peculiar nature, not possessed in general by farming in other countries, which it can exploit to its own benefit and to that of the nation? There is a good deal to support this suggestion. Owing to their low mean elevation and to their oceanic situation, the British Isles are pre-eminently suited to grasses, and though the hill pastures, constituting the best all-round sheep lands in the world, are probably now utilised to the best advantage, much more might possibly be done than we find at present in increasing the food yield of the lowlands. A pasture country such as ours is naturally adapted to numerous fodder crops. The area of these could with favourable conditions be greatly increased at the expense of part of the heavy acreage of permanent meadow land, under some appropriate system of rotation, and the result would be a net gain in food production. Here, however, investigation and research are required to discover new or improved fodder crops that are especially adapted to different British localities. It is essential that such crops should have a productiveness or an economic utility peculiar to the British Isles. For there are few secrets in agriculture, and improvements made here would soon be adopted in other countries if applicable there, and the resulting competition in prices would cancel the advantage aimed at. In the present conditions we are faced with this dilemma: if the country becomes poor enough to find it profitable to divert more labour to agriculture it will not be rich enough to afford the same expenditure upon high-class foods such as meat and butter, for the production of which British resources are peculiarly adapted—unless everyone is willing to work harder so as to have more wealth at command, which does not seem to be the tendency at present. Hence arises the need for specialisation in the direction above referred to, aiming at reduced costs of production through the exploitation of special advantages.

Whatever compromise with the economic situation is suggested by considerations of military safety and of the effects of undue specialisation in industry, the main point remains that any of the conditions capable of promoting an increase of home-produced food would, after all, be such as to alter the relative advantages of agricultural and non-agricultural industries; and these conditions fall under three heads: those that arise from within agriculture itself, such as improvements in methods and organisation (and these are the most desirable), those that are external to agriculture and artificial, such as tariffs, bounties, and subsidies, against which there are weighty objections, and those that would follow from a relative decline in British manufacturing and commercial prosperity which we earnestly hope may never be realised.

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New Tendencies in French Fiction

By Mariette Soman, Docteur d'Université

M. André Maurois, author of *Colonel Bramble*, has recently given some addresses at the Institut Français, entitled "A la découverte des Anglais." Apparently, one of the lessons taught us by the war is that two nations may exist for many centuries cheek by jowl, may engage in wars both with and against one another, may form and dissolve alliances, may teach one another's language and copy one another's hats, and yet in the end remain strangers as far as character is concerned. The French are just beginning to discover the English. It is doubtful whether the English have even begun to discover the French. One of the richest fields for psychological investigation has, up to the present, been almost neglected by us—the field of imaginative literature. The authors who are ranked by the French people of our generation as "first-class" are scarcely known by name on this side of the Channel. Often it is ten or fifteen years before a work of genius such as Guillaumin's *Vie d'un Simple* (*Life of a Simple Man*) is accorded a notice in an English review. The average English reader of French still regards Loti and Bourget as the chief representatives of modern French fiction. *Jean Christophe*, the works of Anatole France, and an occasional novel such as *Marie Claire* or *Colonel Bramble*, have found translators and a large circle of admirers in this country. But what of the numbers of books that are yearly awarded the highest honours of the French nation—the Prix de l'Académie, the Prix Goncourt, the Prix de la Vie Heureuse? Why do we English not ask ourselves what these works stand for, and seek some index to the French mind and character in the literary creations that the French themselves admire?

The list of novels given at the end of this survey has been compiled from French, not English, sources; it contains some of the books that literary France is reading and discussing. It is no idle task for an Englishman to try to discover, first, the mental, moral, and spiritual tendencies of their authors, as representatives of their nation, and then to use them as clues to the mental, moral, and spiritual values of their readers. "Tell me what you read, and I will tell you what you are."

The law of supply and demand holds good in art and literature as in more materialistic spheres. The average Englishman's desire for the greatest amount of physical activity combined with the smallest mental effort produces the prolific adventure-novel, spy-story, and their like. The French love of psychological analysis accounts for the fact that every French novel may be classed as a "psychological novel." The reason why the novels of Pierre Benoît are becoming so popular in England is that they are rare examples of French stories whose interest is historical rather than psychological—something happens. If there is analysis of character, it takes a subordinate place; what matters is the working out of the plot, with its local colour and historical setting.

But *L'Atlantide* (*Atlantis*) and *Pour Don Carlos* (*For Don Carlos*) are freaks among the family of French novels. The normal novel may deal with love, or with religion, or with the various social and industrial questions of the day, or with child-life and adolescence, or with life in some lonely farm in a distant French province; no matter what the outward pretext may be, the underlying motive is inevitably psychological analysis. If classification were not out of fashion, it might be an interesting task to divide French fiction into various classes of psychological investigation, as, for instance, the psychology of passion, the psychology of religious experience, the psychology of maternity, and so on. There is a very large class of novels devoted to the study of childhood and adolescence. Most of these take the form of reminiscences, as, for example, the three volumes by Anatole France which relate the author's early life, *Le livre de mon ami* (*My Friend's Book*), *Le Petit Pierre* (*Little Peter*), and *Pierre Nozière*. Others, less numerous, are stories about a child, written for grown-ups. Of these, M. Lichtenberger's *Mon Petit Trott* (*My Little Trott*) is the best example, though Jules Renard's *Poil de Carotte* (*Carrots*) runs it very close in popularity. Charles-Louis Philippe's *La Mère et l'Enfant* (*Mother and Child*) paints a touching portrait of a child of poor country folk, left to suffer from a lingering disease because his parents are too simple and ignorant to give him the proper treatment. Their attitude is typical of their class; Fate has sent misfortune to their child, and all they can do is to surround him with tenderness and love and leave him to suffer.

The impression of morbidity left by this book is not uncommon. Scarcely one of the child heroes or heroines (these are very rare) of these French tales would be passed by an Englishman as a normal, healthy specimen of humanity. Take the childhood of that infant prodigy, Jean Christophe. Nothing could be more neurotic than the state of that small boy, and the fact of his genius does not sufficiently account for his neuroticism. One of the most artistic descriptions of a childish mentality is that given by Marcel Proust in the first few chapters of *Du Côté de chez Swann* (*Towards Swann's House*). Yet it is quite obvious, from the first page, that the child is hypersensitive, almost hysterical, and that any sane parent would have either packed him off to school or provided him with companions of his own age long before he had had time to find out so much about his own sensations and ideas.

The general impression made on an English reader by all these studies of child-life is that there are no French children; only infants and "young people." But the fact that French authors think it worth while to record their early life, mostly with regret for its lack of joyousness, may perhaps indicate an approaching change in the upbringing of the French child. Up to the present, there appear to be only two alternatives for the child in a French household—either to lead its own inner life (rather a melancholy inner life), apart from the "grown-ups" who make no effort to understand its griefs and joys; or to take an active part in the general affairs of the family, and thus to develop rapidly into a miniature man or woman of the world. Nursery life in the English sense is a thing unknown in France, a state of things undoubtedly resulting from the facts that large families are rare, and that the Latin races are naturally more quick in developing than the

Anglo-Saxon. The sixteen and seventeen year old heroines of Francis Jammes' studies in sex-psychology [Clara Ellébeuse and Almaïde in the *Roman du Lièvre* (*The Hare's Story*)] appear extraordinarily precocious to an English reader. At an age when an English girl would be playing hockey and tennis, training as a girl-guide, studying for examinations, and giving but a very small percentage of her time to the cultivation of the emotions, these French children are breaking their hearts, or at least having experiences that vitally affect their mental and moral development. Francis Jammes deplores the artificial and restricted outlook that allows children to grow up so ignorant of the resources of the outer world, as well as of their own nature. He almost joins hands with the psycho-analysts in his appeal for truth and a free outlet for the natural instincts.

The popular opinion in England is that the French have only one theme in literature, just as they have only one joke—the theme and the joke being *sex.* Until quite recently the " yellow-back " stood as a symbol of the world, the flesh, and the devil ; of late there has come a change, and every French publisher's list contains a fair proportion of titles marked " à mettre entre toutes les mains"—a fact which indicates, not an access of Puritanism, but a widening of the field of interest to include all the phenomena of human experience. The psychology of passion does still occupy a very important place. Henri de Régnier, Marcelle Tinayre, Henri Bordeaux, continue to produce love-stories which are eagerly devoured by the French public. The Prix de la Vie Heureuse was awarded last year to M. André Corthis for his love-story *Pour Moi Seule* (*For Myself Alone*). In *L'Aventure de Thérèse Beauchamp* (*Thérèse Beauchamp's Adventure*), Francis de Miomandre has produced an original and striking variation of the theme known in France as *Elle, Lui et l'Autre,* and in England as " a triangle story." André Gide, in *La Symphonie pastorale* (*The Pastoral Symphony*), has drawn a touching picture of the awakening of love in a young blind girl.

In ninety-nine out of a hundred of these books, love in its highest sense, as that which can only desire the well-being of the beloved, is conspicuously absent. Yet one or two of the younger French authors are beginning to discover something more in the relation of the sexes than the selfish desire for physical and mental enjoyment. The idea that the *mariage de convenance* is immoral is entirely novel, and it is left to a Catholic mystic, Francis Jammes, to propound it (*Roman du Lièvre*, p. 204). The fact that a revolution in the conventional attitude of the French towards marriage has even begun points to a spiritualising process, which can be seen in the numerous studies of religious psychology that are becoming increasingly popular in France. Such a book as Estaunié's *L'Empreinte* (*The Impress*), anti-clerical, anti-Roman, is intensely religious in essence. Estaunié is seeking for reality beneath all the outward manifestations of faith and piety. His hero, a student at a theological seminary, is almost the counterpart of Ernest Renan in his early days at Saint Sulpice. There is the same natural zest for spiritual things, the same trust in the Church and the priests, the same shattering of that trust, and, alas ! the same incapacity to remould the life that has had so powerful a seal set upon it as the Jesuit up-bringing. Renan consoled himself mentally by turning to scholarship, and spiritually by a vague Deism which left him the poetry of religion without its rational basis. Leonard in *L'Empreinte* is a deeper thinker, and believes that there is no alternative. Either the whole Catholic Faith or—nothing. Less courageous than Renan, he drifts back to the monastery, knowing full well that he is compromising and thus throwing away his last chance of finding truth.

Another young man, the hero of *L'Épreuve du Fils* (*The Proving of a Son*), is likewise on the quest for truth. He too is a seminary priest, and finds his ardent faith and hope fail him when he is sent out into the world on his first " cure." But he learns in time the secret of his malady, which to some of us seems to be also at the bottom of Renan's and of Leonard's failure—God will not reveal Himself to those who want Him for themselves ; only in giving can spiritual good be acquired.

The significant fact about these two books and others of the same kind is that the French are concerning themselves less with theological disputes and questions of outward form, than with the spiritual principles that are the basis of religious belief and practice. They are out not for realism, but for reality, and are approaching it from the side of orthodoxy as well as from that of dissent. The age of cynicism, represented by Anatole France, seems to be yielding to an age of faith—not necessarily religious faith, but faith in some ideal of human conduct, enthusiasm for some cause wider than the good of the individual.

That intense love which every Frenchman has for the land, the actual soil of France, is a subject which is very frequently treated in contemporary fiction. Guillaumin's *Vie d'un Simple* (*The Life of a Simple Man*), Pérochon's *Nêne,* and other novels are epics of the soil, showing the Frenchman at his best and as he is rarely seen by English eyes. These simple, God-fearing, hard-working farmers and landowners are as different from the Parisian dandy (so dear to second-rate novelists) as the London clubman, say, of Thackeray's novels is from our own country squires and yeomen. They are the true Frenchmen, and to that same type belong the boys who fight out their religious beliefs in the teeth of tyrannical opposition, and [illegible] and men who went so blithely to lay down their lives for France in the recent war.

Many of the younger generation of French writers were killed in action—Renan's grandson, Ernest Psichari, author of a very beautiful study of religious conversion; Charles Péguy, the mystic, around whom rallied the young Catholics of the intellectual and artistic world; Alain Fournier, whose *Grand Meaulnes* (*Big Meaulnes*) was awarded the Prix Goucourt, and is now widely read in British schools; all of these were stamped by that simple earnestness, love of beauty, and belief in righteousness, that seem to be the watchwords of the new era in France. They are gone, but others are taking their places, and if we would have something of the real France, we cannot do better than read the works of men like Marcel Proust, Henri Bachelin, Estaunié, Claudel, René Boylesve, and Georges Duhamel. They share our interests and our experiences, and it is for us they write. Whether they are geniuses or not, time alone can show. As Marcel Proust wisely remarks: "It takes us a very long time to recognise, in the particular physiognomy of a new author, that brand which is labelled 'great talent,' among our collection of general conceptions. Precisely because it is new, we feel it does not exactly correspond to what we call talent. We prefer to name it originality, charm, delicacy, force; and then one day we become aware that all those qualities are—talent." (*Du Côté de chez Swann.*)

READING LIST

ADVENTURE:
- *L'Atlantide* (*Atlantis*), Pierre Benoft. (Albin-Michel, Paris, 6 *fr.* 75.)
- *Le Lac Salé* (*Salt-Lake*), Pierre Benoît. (Albin-Michel, Paris, 6 *fr.* 75.)

PASTORAL:
- *Nêne*, Pérochon. (Plon-Nourrit, Paris, 6 *fr.* 75.)
- *Vie d'un Simple* (*Life of a Simple Man*), Guillaumin. (Stock, Paris, 6 *fr.* 75.)
- *Le Serviteur* (*The Servant*), Bachelin. (Flammarion, Paris, 5 *fr.*)

CHILDHOOD:
- *Mon Petit Trott* (*My Little Trott*), Lichtenberger. (Plon-Nourrit, 5 *fr.* 95.)
- [1] *Le Petit Pierre* (*Little Peter*), Anatole France. (Calmann Lévy, [illegible])
- *La Mère et L'Enfant* (*Mother and Child*), Charles-Louis Philippe. (Nouvelle Revue française, 5 *fr.* 75.)
- [2] *Le Grand Meaulnes* (*Big Meaulnes*), Alain Fournier. (Emile-Paul, 6 *fr.* 75.)
- [3] *Jean Christophe* (vols. i and ii), Romain Rolland. (Ollendorff, 7 *fr.*)

RELIGIOUS:
- *L'Empreinte* (*The Impress*), Estaunié. (Perrin, 6 *fr.* 75.)
- *L'Épreuve du Fils* (*The Proving of a Son*), Mayran. (Plon-Nourrit, 7 *fr.*)
- *La Colline inspirée* (*The Hill of Inspiration*), Barrès. (Emile-Paul, 6 *fr.* 75.)
- *Pour moi Seule* (*For Myself Alone*), Corthis. (Albin-Michel, 6 *fr.* 75.)
- *La Symphonie pastorale* (*The Pastoral Symphony*), Gide. (Nouvelle Revue française, 4 *fr.*)
- *La Résurrection de la Chair* (*The Resurrection of the Body*), Bordeaux. (Plon-Nouritt, 7 *fr.* 50.)

SPECIAL PSYCHOLOGY:
- *Dansons la Trompeuse* (*Let us Dance "La Trompeuse"*), Escholier. (Grasset, 5 *fr.* 75.)
- *Confession de Minuit* (*Midnight Confession*), Duhamel. (Mercure, 6 *fr.*)
- *Solitudes* (*Solitude*), Estaunié. (Perrin, 6 *fr.*)
- *Du Côté de chez Swann* (*Towards Swann's House*), Proust. (Nouvelle Revue française, 5 *fr.*)

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[1] English translation published by John Lane.

[2] Annotated edition for schools published by the Oxford University Press.

[3] *John Christopher*, published by William Heinemann, translated by Gilbert Cannan.

Reviews of Books

Zoology for Medical Students. By J. GRAHAM KERR. 485 pp. (Macmillan & Co., 1921, 25*s.*)

Professor Kerr has added another to the long list of zoological textbooks. In spite of their number, it certainly cannot be said that there is no room for an addition to the list; probably most of those engaged in teaching elementary zoology find it difficult to recommend any book that seems adequate. But Professor Kerr's work cannot be judged solely as an attempt to produce a book that should supply a general want inasmuch as it is written with a particular syllabus in view—namely, that of Glasgow University. And this syllabus must be a remarkable one if "in a period of ten weeks" a student is supposed to cover the ground gone over in this book. There are nearly 500 pages of almost pure morphology, touching upon practically all the groups of the animal kingdom, while the illustrations are not very numerous. It may be remarked at once that the illustrations given are excellent.

The existence of this type of syllabus is not unknown in England, and, leaving aside for the moment the question as to how far this book is adequate for the syllabus, it may be suggested that this state of things is a misfortune for Zoology. Morphology is but one aspect of Zoology; there is the huge field of experimental zoology; there is ecology; there is the study of variation, inheritance, and evolution, even if physiology is altogether excluded. Surely it may be said that an elementary zoological course should deal with the elements of branches of Zoology other than the purely morphological. They can be so taught as to afford as good an intellectual discipline as morphology affords, and, further, knowledge of them is as essential to a medical student as is Morphology. The fact is that the teaching of elementary Zoology requires overhauling in our universities.

If, however, we ask how far Professor Kerr has succeeded in his task that of writing not so much a textbook of elementary Zoology as a textbook of elementary Morphology—we must confess to a feeling of disappointment. Professor Kerr says that " one of the first endeavours of a teacher of Zoology should be to cast over the minds of his pupils some of the fascination of the most fascinating of sciences," but it may be doubted whether this book will attract many students to its subject. There is a failure to knit the animal kingdom together, to direct attention to the different origins of analogous organs—of the body cavity, for instance—to follow the varying fates of homologous organs in different groups. It provides a clear description of the morphological details of nearly all groups, but it is a dry description rather in the nature of a general taxonomic account of the animal kingdom. There is no attempt to spare the student the learning of those innumerable technical terms which cumber zoological literature. Why should not the " branchiostegite " of the crayfish, for instance, be called just what it is, namely, the gill cover ? The only remarkable feature of the book is the space devoted to parasites ; a large amount of space under this heading is given which will be useful to medical students as it is not easily found elsewhere under one cover.

Turning to points in detail, it is unfortunate that the term " nephridial organs of Vertebrates " should be retained. The use of this phrase tends to obscure the essential fact that these organs are cœlomoducts. The very definite statement on p. 295 (though qualified on the following page) about bony tissue in the dogfish is misleading.

A. M. C.-S.

An Introduction to the Theory of Relativity. By L. Bolton. (Methuen & Co., Ltd., 5*s.*)

Relativity and Gravitation. Edited by J. Malcolm Bird. (Methuen & Co., Ltd., 8*s.* 6*d.*)

So many books of a popular nature have now appeared on the theory of relativity that surely the only outstanding difficulty of the subject must be that of finding suitable titles for them ! These two books, however, are out of the ordinary. The first is by Mr. Bolton, the lucky man who won the prize of £1,000 offered by the *Scientific American* for the best account of the theory in less than three thousand and one words. It is an expansion of the winning essay to twelve times its length. The author has not hesitated to use a little elementary mathematics in the discussion.

The second contains Mr. Bolton's essay in its original form and selections from some of the essays which came near to winning the prize. The sub-editing and piecing together of these so as to describe important parts of the theory in detail has been done by an associate editor of the *Scientific American*, and done rather well. A list of those " honourably mentioned " is given. Two interesting questions arise. One is, " Why is it that the many distinguished Professors of Physics and Astronomy, who competed, allowed themselves to be beaten by one who holds no position at a University ? " and the other, " Why is it that several, who are known to have competed and yet who were not honourably mentioned, still persist in writing about the subject ? "

A. S. R.

Among the Hill-folk of Algeria. By M. W. Hilton-Simpson, B.Sc., F.R.G.S., F.Z.S., F.R.A.I. (Fisher Unwin, Ltd. Illustrations and Map. 21*s.*)

The Berber tribes of Algeria have always held strong claims to a romantic interest as a fair-haired, blue-eyed, physically " European " type in an Oriental setting, and to an ethnological interest as a survival of the indigenous population of North Africa which has remained racially uncontaminated by the great Oriental invasion that flowed round and past their mountain strongholds seven centuries ago.

Their position is not unlike that of the Basques on the eastern slopes of the Pyrenees, that ancient race which was itself untouched by the Aryan tide, and some slight affinity of language has lent colour to the theory that both Basques and Berbers are survivors of the original inhabitants of the great European continent before the Straits of Gibraltar divided it from Africa, cutting off the Berbers, together with that other interesting survival, the Barbary stag, from their Northern relatives.

The interest is greatly enhanced by Captain Hilton-Simpson's discovery of many hitherto undescribed customs and beliefs in the Berber tribe that he studied. The present book is the firstfruits of three winters spent by the author and his wife among the hill-folk of the Aurés Mountains, only thirty miles from the tourist-town of Biskra, yet so remote in their cliff dwellings and almost inaccessible ravines that in many villages the female inhabitants had never seen a European woman.

The chief object of the expedition was to collect native implements and handiwork, and if possible to investigate the primitive native surgery and bring back specimens of the surgical instruments used. This promised to be a matter of considerable difficulty, for, as the unqualified practitioners are discouraged by the French officials and held answerable at law for their failures, their very extensive practice is carried out in secret ; but the author, after gaining the confidence of the people by his interest in hunting and by generous dispensations from his medicine chest, was able to obtain first-hand evidence, finally even to be adopted as a pupil, and he was rewarded by being able to observe the medicine and surgery of Mediæval Europe in actual application.

Trephining the skull seems to be the chief major operation (amputations being forbidden by the Mohammedan religion) and principally employed, rationally though sometimes unnecessarily, for the head injuries common enough in a turbulent race of mountaineers. There is no record that the operation is ever performed " to let out the evil spirit " as used to be done apparently in the South Sea Islands. The operation is carried out in several stages, for tough as the patients are, only a little drilling and sawing can be done each day till a disc of bone is free enough to be removed in one case with a screwdriver. Although neither anæsthetics nor antiseptics are used, a fair number of successful results seem to be obtained. Both [illegible] and [illegible] drugs are used and the general [illegible] [illegible] derived [illegible] much of the Mediæval medicine of Europe, from the writings and tradition of the great Arab physicians of the schools of Cairo and Tunis.

Besides the regular medicine, magic and charms are much used, not by the native doctors but by professional sorcerers, important members of a community to whom malevolent spirits and the evil eye are an ever-present danger. Jinns and demons are kept at bay by the carrying of pungent and ill-smelling drugs, such as red pepper and assafœtida, just as the latter and valerian used to be given in English medicine to drive out the evil spirit of hysteria by making his habitation intolerable. The practitioners of magic among the Shawia tribes evidently wield considerable powers of suggestion, for an eye-witness described in detail to the author the old witchcraft miracle of juggling the moon out of the sky into a bowl of water, though in this case for no greater purpose than to make a love-philtre.

The romantic character with which some writers have invested the Berbers is not substantiated by the author, but we get a picture of a typical, sturdy, superstitious, hospitable Highland people, playing the pipes, as all hill people seem to do from Scotland to the Himalayas, keen hunters and sportsmen (the national game is a furious kind of hockey, played with a juniper branch and a round stone); and in the late war they showed themselves to be as good fighters as they were in the days of the Romans, who found it more convenient to pay them to defend the Southern frontiers than to exact tribute from them as a conquered nation.

The book is well illustrated with photographs and contains a useful appendix of hints to travellers; and, if sometimes we are inclined to look for more explanation and discussion of unfamiliar customs from so experienced an ethnologist, these may be expected in a later and more technical volume in which the findings of the expedition will be collected and analysed. Meanwhile the present volume provides a popular and very entertaining account of a little-known people and, for those who will be stimulated to follow the author not in imagination only, a practical guide to their country.

F. A. H.

The Heart of Nature, or *The Quest for Natural Beauty*. By Sir Francis Younghusband, K.C.S.I., K.C.I.E. (John Murray, 12*s*.)

It is difficult to know what kind of attitude to assume towards this book. We are on the whole inclined to consider it as the embodiment of a philosophy, formed by and during the life of a man of action, who for the purpose of its expression has deliberately thrown to the winds all knowledge of pre-existing philosophies and religions. Early on in his book Sir Francis Younghusband describes the delight that overcame him at discovering a great solitary lily starred with flowers in the Sikkim Forests, as "one of those experiences which most certainly make us younger," because, as he adds, "we are once again children finding flowers in a wood." This last sentence seems to us to sum up the spirit of these pages. The great explorer has sought to recapture "those first fine careless raptures" of his youth and early manhood and to mould them with the experiences, but not the increasing critical faculties, of later life, into a philosophy. If this be the case we can understand why Sir Francis skates, through every page he has written, on the thinnest sheet of ice between him and the entangling waters of philosophy. To mention only two small passages, in the description of the poet as one who "works by spontaneous creativeness . . . is utterly original—a true creator," he comes perilously near to involving himself in the Platonic doctrine of innate ideas, and he approaches and dismisses with extremely flimsy arguments one of the most debated questions of Æsthetics, that "whatever adequately expresses a definite purpose *is* beautiful."

Coming to the core of the book, which could have been adequately developed in a quarter of the space used, we find that Sir Francis is an advocate of a sort of pantheism, somewhat on Shelleyan lines. He believes that the Spirit of Nature permeates everything, lives in everything, energises everything; that Nature is not merciless or hard, but that "in spite of the very evident struggle for existence *She* does not care twopence whether the 'fittest' survive or not so long as what is best in the end prevails"; that "Nature is a Person, and a Person is a process. . . . And actuating the whole process, determining the whole great event, is an inner core of Activity which endures through all the changes. . . . It is what we should mean when we speak of God." As William James pointed out in his *Varieties of Religious Experience*, the rock with which so many pantheists collide is the question of Evil, which their philosophy logically tends to ascribe as having its foundation in God. No very definite attention is paid to the existence of Evil by Sir Francis Younghusband. But the President of the Royal Geographical Society has done a fine thing in these days of materialism by urging on his readers the belief that Matter is not the "end-all and the be-all" of the Universe, but that there is Spirit actuating it everywhere.

To return to less important passages, the book is full of truly-felt and nobly-expressed sentiments, while there are vivid descriptions of the approach to, and first sight of, the Himalayas, of the vast, dark, luxuriant forest in the Teesta Valley, and the uplifting qualities of nights spent in deserts surmounted by starry skies.

E. L.

Modern English Drama: An Outline. By Patrick Kirwan. (National Home Reading Union, 1*s*.)

The writing of a literary or dramatic history of one's own times is beset with dangers. Any man, however aloof and neutral be his mind, is bound to be influenced to some extent by the consensus of contemporary opinion. We doubt if Mr. Kirwan's perspective is always quite a true one. He pays too much attention to the transient charms of Barrie, and to the fantasies of Dunsany, beautiful but too gossamer-like to be handed down as classics of the dramatic art. On the other hand, we found no mention of Masefield's *Nan*—surely one of the greatest tragedies produced on the modern stage.

But admittedly we are influenced by contemporary opinions as much as Mr. Kirwan, and what critic can honestly say that he is in the right? We thoroughly agree with the selections of the other dramatists for special treatment made by Mr. Kirwan, who, besides the work of the two playwrights already mentioned, has most lucidly outlined *The Problem Play* (Sir Arthur Pinero), *The Stage Debate* (Bernard Shaw), *The Drama of Questions of the Day* (John Galsworthy), and the dramatic methods of some less important writers.

Within the thirty-two pages of his pamphlet the author has found space to lead up to his subject with a short, carefully proportioned account of the traditions of English drama, and to round it off with a study of recent foreign influences, and a useful bibliography.

E. L.

Books Received

(Books mentioned in this column may or may not be reviewed in this number, or in a later number.)

ANTHROPOLOGY AND ARCHÆOLOGY

The Witch-Cult in Western Europe. By Margaret Alice Murray. (Clarendon Press, Oxford, 16*s.*)

Studies in North Africa. By Cyril Fletcher Grant. (Simpkin, Marshall, Hamilton, Kent & Co., Ltd., 8*s.* 6*d.*)

CLASSICAL LANGUAGES AND LITERATURE

Alliteratio Latina, or *Alliteration in Latin Verse Reduced to Rule.* By Walter J. Evans, M.A. (Williams & Norgate, 18*s.*)

New Chapters in the History of Greek Literature. Edited by J. U. Powell and E. A. Barber. (Clarendon Press, Oxford, 18*s.* 6*d.*)

GEOGRAPHY

Among the Hill-Folk of Algeria. By M. W. Hilton-Simpson, B.Sc., F.R.G.S., etc. (T. Fisher Unwin, Ltd., 21*s.*)

A Naturalist on Lake Victoria. By G. D. Hale Carpenter, M.B.E., D.M., etc. (T. Fisher Unwin, Ltd., 28*s.*)

East Carelia and Kola Lapmark. Described by Finnish Scientists and Philologists. Edited by Theodor Homén. (Longmans, Green & Co., 21*s.*)

MISCELLANEOUS

Marvels of the Animal World. By W. S. Berridge., F.Z.S. 45 Illustrations. (Thornton Butterworth, Ltd., 7*s.* 6*d.*)

A History of the Perse School, Cambridge. By J. M. Gray, B.A. (Cambridge: Bowes & Bowes, 10*s* 6*d.*)

The Oxford Shorthand. Twenty-seventh edition. (Lincoln [Eng.]: *The Oxford Shorthand*, P. E. Kingsford; and of all booksellers, 5*s.*)

Old Plans of Cambridge, 1574–1798. By J. Willis Clark, M.A., Hon. D.Litt., and Arthur Gray, M.A. Part I: Text with numerous illustrations. Part II: Plans in Portfolio. (Cambridge: Bowes & Bowes, £4 4s. Part I alone, 21s.)

PSYCHOLOGY

The Psychology of Thought and Feeling. By Charles Platt, B.S., Ph.D., M.D. etc. (Kegan Paul, Trench, Trübner & Co., Ltd., 7*s.* 6*d.*)

The Psychology of Society. By Morris Ginsberg, M.A. (Methuen & Co., Ltd., 5*s.*)

SCIENCE

Einstein the Searcher. His Work Explained from Dialogues with Einstein. By Alexander Moszkowski. Translated by Henry L. Brose. (Methuen & Co., Ltd., 12*s.* 6*d.*)

Relativity and Gravitation. Edited by J. Malcolm Bird. (Methuen & Co., Ltd., 8*s.* 6*d.*)

The Ideas of Einstein's Theory. By Prof. J. H. Thirring, Ph.D. Translated by R. A. B. Russell. (Methuen & Co., Ltd., 5*s.*)

Atomic Theories. By F. H. Loring. (Methuen & Co., Ltd., 12*s.* 6*d.*)

The Elements of Physics and Chemistry. A Practical Course for Middle Forms. By Sir Richard Gregory, A. T. Simmons, B.Sc., with assistance of D. W. Hodges, B.Sc. (Macmillan & Co., Ltd., 4*s.* 6*d.*)

The Popular Chemical Dictionary. Second edition. By C. T. Kingzett, F.I.C., F.C.S. (Baillière, Tindall & Cox, 21*s.*)

Examples in Optics. Compiled by T. J. I'A. Bromwich, Sc.D., F.R.S. (Cambridge: Bowes & Bowes, 2*s.*)

Fifty Years of Electricity. By Prof. J. A. Fleming, M.A., D.Sc., F.R.S. (The Wireless Press, Ltd., 30*s.*)

Oil Fuel. An account of its employment by Cadbury Bros., Ltd. (Publication Department, Bournville Works.)

The Making of Reflecting Surfaces. (Printed by the Fleetway Press, Ltd., for The Physical Society of London and The Optical Society. Copies obtainable from: The Optical Society, Imperial College of Science and Technology, South Kensington, S.W.7. 5*s.* Postage 3*d.*)

A Catalogue of British Scientific and Technical Books. (British Science Guild, 10*s.*)

The Rainfall of the British Isles. By M. De Carle S. Salter. (University of London Press, Ltd., 8*s.* 6*d.*)

Ocean Research and the Great Fisheries. By G. C. L. Howell, M.A. (Clarendon Press, Oxford.)

TOPOGRAPHY

Map Projections. 2nd Edition. By Arthur R. Hinks, C.B.E., F.R.S. (Cambridge University Press, 12*s.* 6*d.*)

Correspondence

RADIO-ACTIVITY AND ATOMIC THEORIES

To the Editor of DISCOVERY

DEAR SIR,

Before I left England nine months ago, I was highly interested in the recent advances in radio-activity and in the experiments revealing the nature of the atom and the construction of the elements.

Can you tell me how the work is progressing, and the names of any very recent books or periodicals dealing with these matters? I hate to bother you, but you are the only competent authority I know.

Yours, etc.,
GILBERT F. DOBLE.

JASMINE, KERN COUNTY,
CALIFORNIA.
September 28, 1921.

BOOKS RECOMMENDED

(1) *Radio-activity and Radio-active Substances.* By J. CHADWICK, Ph.D. (Pitman, 3*s.* 6*d.*) Excellent on the physical side of the subject.

(2) *Atomic Theories.* By F. H. LORING. (Methuen & Co., Ltd., 12*s.* 6*d.*)

(3) *Radioaktivität.* By Dr. K. FAJANS. An excellent synopsis of the chemical side in German. It is published by Vieweg & Co., of Braunschweig, Germany, and should cost in the United States about 75 cents.

A. S. R.

SCIENCE AND INDUSTRY

To the Editor of DISCOVERY

SIR,

The Editorial comments on that part of the speech of the President of the British Association which dealt with the relation of science to war cease at the point where they tend to become most fruitful. The more important question, surely, is the value of science to peace. Perhaps this is assumed. But is it not also a fact, to amend the quotation from Sir Edward Thorpe's speech, that an educated public will refuse to give credit to any body of scientific men who employ their talents in devising means to develop and perpetuate a mode of *existence* which is abhorrent to the higher instincts of humanity? The harnessing of solar energy in all its forms by men of science has given to civilised mankind a machine of enormous capability of production—and has at the same time dispossessed millions of the necessities of life.

The men of science are, of course, no more to blame for producing the horrors of peace than for creating the horrors of war, but it seems a pity that Sir Edward Thorpe did not fully develop his argument, and press for scientific men to employ their talents in devising means to develop and perpetuate a mode of *social organisation* which is acceptable to the highest instincts of humanity, and wherein science would enrich and not destroy the people.

Yours, etc.,
A. J. LILLIMAN.
Hon. Sec. and Treasurer,
Watford and District Association,
National Union of Teachers

32 QUEEN'S AVENUE,
WATFORD.
October 3, 1921.

ELECTRONS AND ETHER WAVES

To the Editor of DISCOVERY

DEAR SIR,

Is not the solution of the problem stated by Sir William Bragg in your September issue to be found in the nature of the medium? It is hard to conceive an incompressible, frictionless fluid, such as the Ether of Space, but if such exists, the analogy of the falling log of wood and the ship 1,000 miles away must require considerable modification. We must imagine that the surface of the sea is perfectly rigid, and that therefore none of the energy transmitted by the falling log can be dissipated in forming ripples or waves.

The sea being formed of an incompressible fluid, would not the energy be transmitted as an impulse to the loose timber in the vessel and, encountering a plank of the same weight as the original log, shoot it up to the same height, eliminating friction?

In other words, can there be actual waves in an incompressible fluid, or do not the waves form only when the impulse encounters matter?

Yours, etc.,
H. STANSBURY,
Captain R.N.

6, OAKMOUNT AVENUE,
SOUTHAMPTON.
October 9, 1921.

UNEMPLOYMENT

To the Editor of DISCOVERY

DEAR SIR,

Regarding Professor Knoop's interesting article on unemployment, there is one method of alleviating the distress which is seldom touched upon by writers; namely, the conversion of some of the employee class (either employed or unemployed) into master men by means of a State loan of capital (money, tools, or materials) in cases where the employee has the necessary good character and trade ability, but lacks the necessary funds.

There are many cases at present where unemployed men are working at home at their trade, but are only partially successful on account of the lack of capital necessary to make proper "master" men of them.

I suppose a State loan on the security of a man's personal character and skill, and at a low rate of interest, would practically mean a State Bank, and would interfere with the great banking interests of the country, and that, therefore, the idea is "scotched" by politicians. There is no doubt that many practical men of good character would be just as successful as men who often have no technical knowledge of the business they engage in, but who entered into it with capital which many men of the former class lack.

It does not seem a perfect system, from a scientific point of view, that the possession of capital should have such a great advantage over years of accumulated skill and knowledge.

I remain, yours, etc.,
GEO. MCLAGGAN.

LEWES.
November 9, 1921.

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